AN ARCHAEOLOGICAL VIEW OF THE HISTORY AND VARIATION OF IRONWORKING IN SOUTHWESTERN TANZANIA

By

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A DISSERTATION PRESENTED TO THE GRADUATE SCHOOL OF THE UNIVERSITY OF FLORIDA IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

UNIVERSITY OF FLORIDA

1995

Dedicated to my father, Baltasar Mapunda, whose commitment to my education has led me to where I am today.

Mungu ampumzishe kwa amani! Amina!

ACKNOWLEDGEMENTS

This work would not have been possible without the combined efforts of many individuals and organizations. I would like to express my sincere appreciation to my senior advisor, Dr. Peter Schmidt, for his advice, guidance, encouragement, and constructive criticism and insights that helped to improve the quality of the field research, interpretation, and the writing of this dissertation.

I would also like to thank the other members of my supervisory committee, Drs. Steven Feierman, Michael Moseley, Steven Brandt, John Ambrose, and Terry Childs. They were always ready when I needed them for guidance, reviews, and comments. Their time, concern, and encouragement are greatly appreciated.

Special thanks go to the following individuals for their assistance in material analyses: Dr. S. Kapilima, University of Dar es Salaam, helped me with geological analysis; Dr. Susan de France, University of Florida, helped to confirm fauna species; and Dr. Priya Bendale and Richard Crockett, University of Florida, provided valuable guidance during chemical analysis.

Appreciation is also extended to my colleagues and friends at the University of Dar es Salaam and the University of Florida for their good wishes, prayers, encouragements, insights,

suggestions, comments, and positive criticisms. Cordial gratitude goes to the officials in the research area, informants, and crew members for their cooperation and keen interest in the research project. I would also like to thank the villagers for their friendliness, generosity, and cooperation during the research time.

My gratitude goes beyond measure and words to my wife, Victoria Mapunda, for sharing with me all the pain and frustration during this period, especially my physical and, often, mental absence from the "world" I vowed to share with her.

I remained mentally and physically healthy throughout my school life because of the endless tender love, care, support, and encouragement from my dear parents, Baltasar Mapunda† and Mercyana Mahundi, my sisters, Kanasia, Matia, Regina, Filomena, Maryanna, and Aponsiana, and my brother Daudi†. To all I say "Musengwili sana!"

I am also indebted to various institutions for their financial support. My Ph.D. studies were supported by a scholarship from the Ford Foundation, and this research was made possible by grants from the Ford Foundation, the NORAD, the Sigma Xi, and the University of Dar es Salaam.

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May, 1995

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This dissertation presents an archaeological perspective of the socioeconomic and cultural history of southwestern Tanzania during the last two millennia. Archaeological field research discussed in this study was conducted in Nkansi District, Rukwa Region, southwestern Tanzania during 1992 and 1993. This research had three major goals: to establish the archaeological potential of the area; to reconstruct the socio-economic and cultural history during the Iron Age; and to establish the history of indigenous ironworking technology. The archaeological field research yielded 75 sites, including Later Stone Age microlithic industries, Iron Age settlement sites, ritual locations, and iron-smelting and iron-refining sites.

Much of archaeological inquiry focuses upon ironworking. Three different technologies are discussed: the <u>katukutu</u>, the

malungu, and the Barongo-type. These technologies differ in metallurgical attributes such as furnace morphology, slag, tuyeres, charcoal species, ore chemistry, ritual presentation, and spatial and temporal distributions. Radiocarbon dates indicate that the katukutu technology is the oldest of the three; it dates between 1550 and 1800 A.D. The malungu and the Barongo-type technologies date later than the mid-nineteenth century. Some settlement sites, indicated by Kalambo and Triangular Incised pottery, daub, and fauna remains, however, date to the tenth century A.D.

A multivariate approach is used in this study to examine both inter- and intra-technological variations through attribute analysis of materials such as furnace forms and decorative applications, tuyeres, slag, ore, and ritual medicines as well as chemical and metallographic analyses of slag, blooms, ore and metal artifacts. These analyses help to establish development of ironworking technology during the Later Iron Age in southwestern Tanzania.

This dissertation demonstrates that variations in iron technology in southwestern Tanzania were caused by a systematic and constant struggle by different groups of smelters to adapt to different natural and cultural influences and limitations, including resource depletion (e.g., charcoal wood, medicinal woods, iron ore, and termite clay); population

growth and migrations; and beliefs (medicinal and cosmological). This disproves the conservative beliefs that pre-industrial African metallurgy was static or that technological variations resulted from uncertainty in what the metallurgists were doing.

CHAPTER 1

INTRODUCTION

This chapter is divided into two sections. In the first section I outline and discuss the history and historiography of Iron Age research conducted in East and Central Africa[1] during the last 100 years. By doing so, I put the historiography used in this work into a historical context and justify its selection. In the second section I present and account for the selection of research objectives, research universe and the theoretical orientation of the dissertation, as well as summarize the dissertation coverage.

History and Historiography of Iron Age Research in East and Central Africa

Several scholars (Hall 1987, 1990; Shaw 1989; Musonda 1990; Holl 1990; de Maret 1990; Robertshaw 1990b; Chami 1994) have attempted to write an historical review of

[1] The term "East and Central Africa" as referred to in this work includes the present day Kenya, Uganda, Tanzania, Rwanda, Burundi, Eastern Zaire, Zambia, Northern Zimbabwe, Malawi, and Northern Mozambique. This review (and the whole dissertation for that matter) focuses on this region because this is where the dissertation research was conducted (specifically, southwestern Tanzania).

paradigms and factors which influenced research and the writing of archaeology in Africa in the ongoing century. However, a critical review of their approach indicates that most of them have a bias towards external factors. More emphasis is placed on the theoretical and philosophical background of the archaeological researchers. Discussions often center on prejudicial beliefs such as social darwinism, the hamitic myth, and diffusionism as well as liberal theories including structuralism, processualism, post-processualism and post-modernism. With the exception of literature from southern Africa where political conflicts have been addressed in archaeology (Hall 1987, 1990; Kiyaga-Mulindwa 1993), internal factors, including national politics, influences of other disciplines, and archaeological "visibility" which, in my view, have equally affected the choice of subject matter, research areas, interpretation of the findings, and publication in most regions of Africa have not received the kind of emphasis they deserve.

In this historiographic review I deliberately bias my discussion towards internal factors. This is not meant to undermine the role of theories and philosophies of the western scholars who have dominated the study of archaeology in Africa (in fact those factors are also brought up in the discussion). My objective is to complement the current popular factors for the development of archaeology in East and Central Africa and the whole continent.

Three categories of internal factors are examined: national politics, archaeological visibility, and interdisciplinary influence. National politics refers to influences of colonial and post-colonial governments in prioritizing research topics, funding, and interpretations. Archaeological visibility refers to the preference archaeologists sometimes have towards materials that are easily visible especially features such as architectural monuments, rock art, and furnaces as well as the availability of written information. The influence from other disciplines refers mainly to history and, to some extent, ethnography. To understand the role of history in influencing archaeology one needs to bear in mind the fact that in Anglophone countries (where most of East and Central Africa belong) archaeology was (and to a large extent still is) considered a handmaiden of history (Holl 1990; Robertshaw 1990b).

A critical analysis of archaeological research conducted in East and Central Africa based on criteria such as research topics, aerial coverage, interpretation and modes of writing reveal four broad patterns referred to as archaeological historiographies. These include colonial historiography, dating between the 1880s to the 1960s; neo-colonial historiography, dating between the 1960s and the mid-1970s; nationalist historiography, dating between the mid-1970s and the 1980s; and post-nationalist historiography of the 1990s[2]. In discussing these historiographies I focus on the Iron Age and

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[2] These are arbitrary dates.

iron metallurgy, areas most relevant for this work. This helps to identify and justify the theoretical and methodological orientation of the current work discussed in subsequent sections.

Colonial Historiography (ca. 1880-1960)

The history of archaeological research in East and Central Africa, and, indeed the whole of Africa began with the commencement of colonial occupation (Gowlett 1990). Throughout the colonial period archaeological research in East and Central Africa, with the exception of the coast, concentrated primarily on the Stone Age; the Iron Age[3] was treated as a marginal topic. Iron Age research along the coast started relatively early (e.g., Kirkman 1952, 1954, 1959; Freeman-Grenville 1958) because researchers were attracted by the architectural monuments which, according to the evolutionary scheme (Morgan 1877; Childe 1951, 1957), were cultural traits of the "civilized or superior races." It was therefore important for the colonial historians and archaeologists to know and identify with their fellow Caucasians who came before them. By insisting that the monuments and Swahili culture in general were products of

[3] The two terms "Stone Age" and "Iron Age" as used in this work take into account both time and technology. "Stone Age" refers to the time period in the history when stone was used to manufacture tools and weapons. In East and Central Africa this time period ranges from 2.5 million years ago to the middle of this millennium. The "Iron Age" refers to the time period in the history when iron was used for the production of aesthetic and/or utilitarian products. Based on the chronometric dates available up to now this time period in East and Central Africa ranges from 2500 through the beginning of this century.

foreigners these scholars were obliging themselves to their respective colonial governments whose goal was to demonstrate the inferiority of Africans thus bringing forth the "moral justification for the colonial settlement of Africa" (Hall 1990:103).

In addition to monuments, the coast had a written history, which, again, the colonial archaeologists and historians valued most. Commenting on the uneven research coverage between the coast and the interior, Andrew Roberts, an outstanding historian of this time, writes:

> Given the nature of the evidence, it is easy to understand preoccupation of historians [and archaeologists], up to the late 1950s, with the history of the coast and islands of Tanzania and other parts of eastern Africa. From the beginning of the Christian era, travellers from literate countries visited the [East African] coast, and we have written records of many such journeys. Furthermore, a literate Muslim civilization, linked through trade and migration to other parts of the Indian Ocean, developed on the coast. This left both written records and stone buildings, the ruins of which marked obvious sites for excavation by the archaeologist. By comparison, the history of the peoples of the interior presented more formidable challenge. This was partly because the evidence--whether archaeological, oral or literary--was less easy to locate and exploit (Roberts 1968:v).

Field research pertaining to iron technology was virtually absent in East and Central Africa during this time period (and did not begin until the late 1970s (Schmidt and Avery 1978; Avery and Schmidt 1979; Van der Merwe and Avery 1982)). One wonders why the interest came so late considering the fact that

there was a large corpus of ethnographic information on the subject collected by European explorers, travellers, and missionaries in the nineteenth century (Waller 1874; Burton 1860) as well as those collected by both amateur and professional ethnographers in the subsequent decades (Last 1894; Wyckaert 1914; Greig 1937; de Rosemond 1943). It would therefore have been easy for archaeologists to continue from where previous reporters had left. But, surprisingly, East and Central Africa lagged behind in research pertaining to iron technology and metallurgy in general compared to northern, western, and southern Africa where works such as Garland and Bannister (1927), Bellamy (1904), Desplagnes (1907), Stanley (1929) and Dart and del Grande (1931), to name but a few, appeared much early. Why?

To understand this paradox we need to bear in mind that the absence of interest in iron metallurgy was not confined to this subject but rather to the Iron Age as a whole. As Roberts lamented,

> For the Stone Age, of course, archaeologists had already unearthed much important evidence at Olduvai[4] and elsewhere. But the Iron Age received little attention from archaeologists (Roberts 1968:v).

It seems that East and Central Africa lacked the kind of stimuli for metallurgical research the other regions had. Accounting

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4 It should be noted that the discovery of the archaeological and palaeoanthropological sites at Olduvai George was accidental (Leakey 1971) and subsequent research there was more a function of "archaeological visibility" rather than systematic research undertaking.

for the interest in northern Africa, Kense, for example writes, "the focus of investigation inevitably concentrated upon northern Africa, since this area was considered the probable point of contact between the iron-using Middle East and the Mediterranean world and Africa" (Kense 1983:16). Being close to the Middle East, the world's earliest ironworking center (as will be demonstrated in chapter 3), northern Africa, it was hoped, could provide evidence for the diffusion of iron to Africa. Under this assumption, West Africa was believed to have bridged the technological diffusion between northern Africa and sub-Equatorial Africa (Shinnie 1967, 1971).

The early rise of research interest in the Iron Age and iron technology in southern Africa is accounted for by political reasons (Hall 1984, 1987, 1990; Kiyaga-Mulindwa 1993). The Iron Age research there was needed to demonstrate that the presence of Black Africans (especially Bantu-speakers) in southern Africa was recent and, therefore, both Whites and Bantu-speakers had an equal right in occupying the land since both were newcomers. Kiyaga-Mulindwa (1993) laments that,

> The notion that southern Africa was once an empty land (Marks 1980), a claim most strongly encouraged by agents and sympathizers of south Africa's regimes in order to justify white domination in southern Africa, has created a general problem in the presentation and interpretation of the past. . . . Much of the existing literature has created an impression that there were no iron using farmers or pastoralists in the area until the arrival of the Setswana-speaking groups across the Madikwe (Marico) river in the Transvaal. This event took

place as recently as the middle of the seventeenth century AD at the earliest (Kiyaga-Mulindwa 1993:386)

Iron Age research there was also used to prove that Zimbabwe ruins (considered by the colonial anthropologists/ archaeologists as a key index of "civilization") were not built by Africans but by a "superior race" (Caucasians). This fraudulent interpretation had two objectives: first, to demonstrate the inferiority of Africans, and second, to prove that the Caucasians lived in southern Africa before the coming of the Bantu speakers or before the sixteenth century, the official date of the first Dutch settlement in the Cape Coast of South Africa (Hall 1987).

In short, the selection of research locations throughout the colonial period was based on archaeological visibility (as opposed to systematic survey), as well as written documentation (referring to the coast). Interpretation and writing was influenced by colonial ideology and philosophy. In terms of spatial and subject coverage, the coast was better investigated than the interior and very little research was done on the Iron Age and virtually none on iron technology.

Neo-colonial Historiography (1960s to mid-1970s)

This time period was marked by expansion of Iron Age research in the interior. Paradigmatically, this was a time of transition from colonial to liberal (neo-colonial) thoughts. Outstanding Iron Age research included Robinson (1961, 1968, 1969, 1970), Posnansky (1961), Inskeep (1962), Fagan and van

Noten (1964), Chapman (1967), Fagan and Yellen (1968), Sutton and Roberts 1968; and Soper (1967a, b, 1971a, b), to name but a few. This change can be attributed to the emergence of the C14 dating technique, as well as pressure from historians who wanted to expand African history beyond--what Posnansky called, "the bounds of the colonial period" (Posnansky 1965:1). There was a general plea during this time that "the trowel of the archaeologist is urgently needed to begin where the historian must perforce leave off" (Freeman-Grenville 1962:2). In short, there was a growth of interest among historians to write diachronic histories--histories that could reveal what had existed before the coming of White people.

We should also bear in mind that this was the decade when nationalism (struggle for decolonization) reached climax in East and Central Africa. Therefore historians, especially those who disagreed with the colonial paradigm (Coupland 1938), were free after independence to investigate beyond the colonial period to disprove this claim, or at least comply with the political sentiment of the time. As Neale notes,

> It was this picture of failure then, that African historians had to deal with when, in the sixties, the political position of Africans was reversed and colonial history, which had rationalised their subjection, was rejected. The new nations needed a new history, and it must refute the old, because the old was both wrong and damaging to African pride (Neale 1985:9).

Given the fact that very little Iron Age archaeology had been done until then, efforts to extend the time dimension of history faced a conspicuous cultural and temporal gap (between

the historic period and the Stone Age period). Archaeologists intensified research on the Iron Age to remedy this problem and, by the end of the decade, books dealing specifically with the Iron Age appeared (e.g., Fagan 1967; Fagan et al. 1969; Robinson 1970, 1973).

A critical assessment of the Iron Age research during this period indicates that research topics were highly restricted. They consisted almost exclusively of the Bantu migration, monumental architecture, and pottery (see for example Posnansky 1961; Inskeep 1962; Fagan and van Noten 1964; Chapman 1967; Sutton and Roberts 1968; Soper 1967a, b, 1971a, b, c).

The emphasis on Bantu migration was influenced by both historians and ethnographers. It should be realized that much historical and especially ethnographic research conducted in East and Central Africa during the colonial period, such as Richards (1939), Tew (1950), Wilson (1958) and many others, were directly sponsored by colonial governments. The purpose was to understand better the people who were governed. Bantu-speakers, the majority of the indigenous people, became the focus of study for this goal. Emphasis on Bantu research continued through the post-colonial period. In 1965 the Astor Foundation founded and sponsored a project called "The Bantu Studies Research Project" which dealt specifically with "the origins and early migrations of the Bantu" (Soper 1971a:1). This project was carried on by the British Institute in Eastern Africa (Soper 1971a), the only stable organization that has continued

to pursue Iron Age research and publication in Eastern Africa since the early 1960s.

Monumental architecture, such as Bigo and Bweyorere in Uganda, attracted interest similar to that along the coast (Oliver 1959; Shinnie 1960; Posnansky 1968, 1969), however, with different goals. Archaeologists and historians became aware of the research imbalance between the coast and the interior and they wanted to rectify this problem as they provided evidence for Africa's achievement during the pre-colonial period. Unfortunately, these efforts met two impediments: archaeological invisibility and the hamitic myth. Commenting on the invisibility, Connah writes:

> The basic problem [was] one of archaeological visibility. ... For instance, the capital city of Buganda, ... a state near Lake Victoria, was described [by Ashe] in 1889 as one of the great capitals of Africa, but it was constructed totally of grass, wood and other organic materials and it moved frequently, particularly on the death of the Kabaka, the ruler of Buganda. The sites of these large settlements [were], therefore, unlikely to have much depth of deposit or structural remains and no archaeological investigation of them seems ever to have been attempted (Connah 1987:214).

Additionally, a few that were investigated such as Bigo were interpreted (Oliver 1959; Shinnie 1960) as having been built by Hamites (Caucasian pastoralists from the north)--an interpretation which paralleled that used by their counterparts along the coast to explain the rise of Swahili culture. The contribution of Black Africans was once again obscured.

Pottery became important in Iron Age research because of its ubiquity and preservability. It was (and still is) used to answer questions that lacked material evidence. Such questions included ethnicity, language, and population distribution in space and time (Soper 1971b, c).

The preoccupation with the three research topics (Bantu migrations, monumental architecture, and pottery) during this period perhaps explains why there was a lack of concern among archaeologists about what entailed the "Iron Age". The term "Iron Age", though it denotes technology, was defined only with reference to time. In other words, when talking about the "Iron Age" little concern was given to the presence of iron metallurgy. The terms "Iron Age" and "ironworking" were used as synonyms. This irony is nicely demonstrated by Grahame Clark in his discussion on the Iron Age of East and Central Africa. He writes;

> East of the Congo iron-working was being practised by the inhabitants of Kenya, Ruanda, Uganda and Tanzania, identified in the archaeological record by bowls and globular pottery vessels with dimple bases, as early as the first century A.D. About the same time it extended as far south as the Zambezi where it was associated with analogous pottery. Beyond the Zambezi iron-working was practised by the first inhabitants of Zimbabwe whose settlement, dating from before A.D. 300, was found stratified under the stone necropolis. By the fifth century it had spread beyond the Limpopo, where it was carried on by stock-keeping farmers at the site of Broederstroom (Clark 1977:244-245).

In sum, the neo-colonial historiography was marked with a paradigmatic contradiction: both archaeologists and historians

desired to free themselves from the colonial paradigm and demonstrate Africans' achievements prior to the coming of White people, but at the same time they used the same colonial (diffusionist and racial--hamitic) paradigms to explain change in Africa. Such contradictions are clear evidence of a colonial legacy. Iron Age research, however, expanded in the interior but was restricted to Bantu migration, pottery and architectural monuments. Iron technology was still less interesting to archaeologists in both East and Central Africa.

Nationalist Historiography (mid-1970s to 1980s)

This time period was characterized by the emergence of systematic research on iron technology. Examples include the work of Peter Schmidt and his colleagues (Schmidt 1978b; 1980; 1981; Schmidt and Avery 1978), van Noten (1979), and van Grunderbeek and her colleagues (van Grunderbeek 1981; van Grunderbeek et al. 1983) in the interlacustrine region, as well as van der Merwe and his colleagues in central Malawi (Van der Merwe and Avery 1982).

The research in the interlacustrine region concentrated on the early ironworking. Chronometric dates from excavated sites showed that iron technology in the interlacustrine region began more than 2000 years ago (Schmidt and Childs 1985; van Grunderbeek 1981; van Grunderbeek et al. 1983). This finding significantly affected how subsequent researchers viewed the history and development of iron technology and the Iron Age not only in East and Central Africa, but in Africa as a whole. The

simplistic diffusionist theories used previously to explain the spread of the knowledge of ironworking into the region were called into question. One such theory postulated that the knowledge of iron metallurgy in Eastern and Central Africa diffused from Meroe (Shinnie 1967). The research in the interlacustrine region challenged this allegation. The archaeological evidence showed that ironworking there began earlier than at Meroe, and that the smelting techniques applied in the two regions differed significantly. For example, smelters at Meroe used domed, slag tapping furnaces (Shinnie 1985), whereas in Northwestern Tanzania they used low shaft, non-slag tapping furnaces (Schmidt and Childs 1985).

The emergence of iron technology as a research theme in the archaeology of East and Central Africa came with a package of field methods and techniques which included experimental observations of smelting and forging processes and significant reliance on oral traditions (Wembah-Rashid 1969; Schmidt 1981; van der Merwe and Avery 1987). Along with these experiments, several films and video tapes were produced. Examples include Ironworking in Ufipa--a film documentation of the Fipa iron-smelting process conducted in an experimental setting in Dar es Salaam and organized by the National Museum of Tanzania in 1967 (National Museum of Tanzania 1967 (Wembah-Rashid 1969)); The Tree of Iron a film and video tape documenting iron smelting among the Bahaya of northwestern Tanzania as reconstructed in the early 1980s by former smelters (O'Neill et al. 1988); and a reconstruction of Shona

smelting using domed furnaces and goat-skin bellows (Dewey, W., quoted by Herbert and Pole 1988).

Archaeometallurgy also became an important methodological aspect in the archaeology of iron technology in the area. The works of Peter Schmidt and his colleagues in the northwestern Tanzania in the late 1970s and the early 1980s (Avery and Schmidt 1979; Childs 1986) are good examples. It should be observed that a few archaeologists used to include mineralogical or petrographic information of metallurgical materials in their monographs or books in the past as well, but this information was appended (Clark 1974) rather than integrated into the text or discussion.

The difference between this period and the previous one was that now archaeologists were bold enough to interpret and write about what they considered to be independent African achievements. They argued that Africans too had been innovative and that they not only had a longer history of iron production than previously thought, but also their iron technology was in many ways more sophisticated than that of contemporary Europe (Schmidt 1981). Additionally, they questioned the traditional diffusionist explanation of the origin of iron technology in sub-Saharan Africa (believed to have diffused from the Middle East) and strongly advocated a local-invention hypothesis (Schmidt and Avery 1978) (see details in chapter 3).

Despite the good intention and achievements these researchers have had, several problems are apparent. First, the

need to prove that indigenous African iron metallurgy has a longer history than that claimed by the colonial and neo-colonial historians and archaeologists resulted in paying more attention to the Early Iron Age and neglecting the later period. Researchers started racing for "the earliest evidence" instead of explaining processes involved in the historical development of the iron technology.

Second, most researchers tended to concentrate on only one or two variables, namely smelting furnaces and bellows. Other materials such as tuyeres, slag, charcoal, quarried ores, ore quarries, metal objects, bloom, bellows, anvil, hammers, etc. were not given enough emphasis. It is true that some of these materials (e.g., bloom, metal objects, and wooden bellows) weather more quickly than furnaces and are difficult to find in the archaeological record, but it is also true that some materials that were not sufficiently investigated such as slag and tuyeres have a comparable if not a better chance of preservation than furnaces. By concentrating on just a few variables or a few samples investigators often failed to recognize intra-regional and intra-technological variations resulting in failure to appreciate change through time. Consequently, they have sometimes labeled African iron technology and the societies as static when in fact it was their methodology that was static. A case in mind is the following interpretation from southern Africa:

> No essential differences were found between the composition of 9 slag samples from the Early iron Age

site near Broederstroom and that of a number of samples from six later Iron Age sites of the central and western Transvaal, Swaziland, and Botswana. This fact strengthens the concept of an iron-smelting technology that remained basically unchanged during the whole period of the south African Iron Age (4th to 19th century AD) (Friede et al. 1982:47).

The same authors in another publication argue along the same line of thought:

> In any society, innovations are an answer to challenges or needs, but, in most regions of Africa south of the Limpopo, few radical technological changes such as those required in a high-temperature steel-making process seem to have occurred during the Iron Age (ca 3rd to 19th century AD). The traditional African bloomery-smelting process was adapted to the requirements of apparently fairly static societies .... A relatively simple smelting technology seems to have been sufficient for the needs of the South African subsistence farmer (Friede et al. 1984:296).

Post-nationalist Historiography (1990s)

Metallurgical researchers in the 1990s seem to have carried forward all 'good' elements of the 1980s. For example, investigations are more focused and intensive (Killick 1990; Barndon 1992; Kusimba 1993). That is to say, iron technology does not appear as a side subject as was generally in the past but as a primary research goal. Ethnographic inquiries on former smelters continues to be emphasized (Barndon 1992) within a framework of "rescue ethnography". This is because "these technologies are now extinct and the few surviving

former ironworkers are elderly" (Childs and Killick 1993:318). After a decade or so all will disappear.

We also see new directions: the 'earliest evidence syndrome' seems to have lost power. The Later Iron Age is progressively investigated (Killick 1990, Barndon 1992; Kusimba 1993). Multiple technological and symbolic variables are scrutinized through attribute analysis as well as microscopic studies (Killick 1990; Childs 1990, 1991a, b; Kusimba 1993).

Finally, I appeal to researchers dealing with indigenous African metallurgy to direct our efforts towards exposing and understanding intra-regional and intra-technological variations. This is because these variations are the key towards a better understanding and appreciation of the innovative skills the African metallurgists had and their constant struggle to meet the ever-growing demands of iron both symbolic and utilitarian. Therefore, the central thesis of this dissertation is that the technological and symbolic variations such as those presented in this work are not indications of uncertainty of what the metallurgists were doing, as some scholars (Cline 1937) put it, but rather as clear proofs of constant experimentation conducted by the metallurgists in efforts to improve both the quantity and quality of iron which was highly valued in all walks of life: economically, politically and religiously.

Research Justifications

Research Scope

The field research upon which this dissertation is based involved 1) ethnographic investigation, 2) archaeological survey, and 3) excavation. Ethnographic studies were conducted to collect information pertaining to the history and socioeconomic aspects of the contemporary inhabitants in the research area. This information was expected to contribute to the reconstruction of the later history of the region as well as offer insights that could assist in interpreting the archaeological findings from both site survey and excavations through the use of controlled analogy. Archaeological survey was aimed at locating occurrences of archaeological materials, studying their spatial distribution, and examining archaeological land use patterns. Sites located during the survey were scrutinized for their potential contribution to the goals of the project. Excavations were conducted to expose subsurface materials in order to understand their use patterns, depositional sequence, cultural and geological stratigraphy, as well as obtain radiometrically datable materials (especially charcoal).

Research Universe

The research was conducted in Nkansi District, Rukwa Region, Southwestern Tanzania (Fig. 1.1). The Rukwa Region in general and Nkansi district in particular were selected as the

research universe because the region was found to have rich ethnographic information pertaining to ironworking. Indigenous ironworking continued in the region until relatively recently: the 1930s in most parts and the 1950s in Katumba-Azimio, south of Sumbawanga (Wright 1982, 1985; Wembah-Rashid 1969). The presence of relics of ironworking (e.g., furnaces, tuyeres, and slag) on the landscape was also well known.

Furthermore, linguistic (Ehret 1991) as well as archaeological evidence, especially from Kalambo Falls (Clark 1974), a site located 70 km south of the current research area, indicated that the region along the shore of Lake Tanganyika was very likely inhabited throughout the Iron Age. Ecologically, the area seemed similar to other localities where Early Iron Age sites have been found in East and Central Africa, such as along Lakes Victoria (Leakey et al. 1948; Chapman 1967; Schmidt 1978b, 1980), Kivu (Hiernaux and Maquet 1956), Nyasa (Robinson 1970, 1973; Mapunda 1991b; Mapunda and Burg 1991), and Tanganyika (Clark 1974).

The field-research was focused on four localities: Kirando[5] and Kala along the shore, King'ombe on the Fipa escarpment, and Kalundi on the Fipa plateau (Fig. 1.2). Kirando and Kala were selected on ecological and logistical grounds. Both were well protected natural harbors with relatively wide, flat and well drained hinterlands, dissected by perennial rivers.

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[5] Kirando is a collective term for a large shore plain which encompasses several villages including Katete, Mtakuja, Kipili, Katongolo, Masolo, Mpata and some other smaller settlement clusters.

The fact that the neighboring areas lacked shore plains suggested that both Kirando and Kala had a high likelihood of attracting human occupation in early history, as they do today. Furthermore, both places were easily accessed by road from Namanyere and Sumbawanga, District and Regional Headquarters, as well as by ship and boats. Kalundi and King'ombe were selected in the field with the help of informants once it was observed that the shore localities (Kirando and Kala) were biased towards the katukutu and "Barongo" type technologies with almost no representation of the malungu technology[6]. Thus selection of localities on the Fipa escarpment (King'ombe) and Fipa plateau (Kalundi) were meant to bring a balance in the research coverage, as well as provide an opportunity to compare the three technologies.

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[6] Both katukutu and malungu terms have been borrowed from Fipa language. Malungu has its root in amalungu (singular icilungu), meaning (tall) iron furnaces. Katukutu roots from katukutu a word for short or dwarf (due to their size vis-a-vis malungu). "Barongo technology" is similar to that practiced by Barongo smelters in Mwanza region and described by Rosemond (1943) and Schmidt (forthcoming). See chapter 3 for description of the Barongo technology.

Fig. 1.1 Rukwa Region

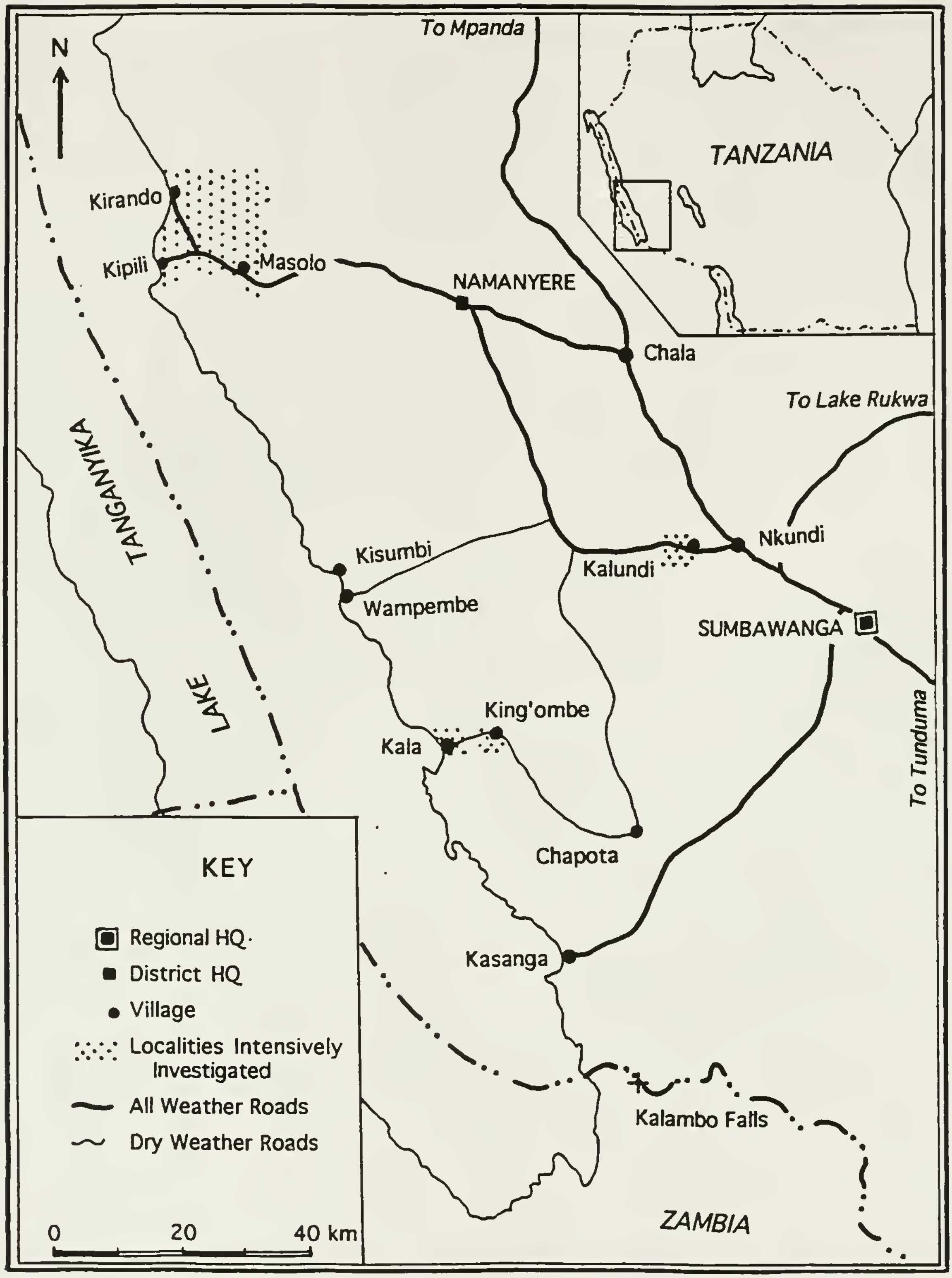

Fig. 1.2 Localities Intensively Investigated during the Current Field Research.

Research Objectives

This research had three major goals: establish the archaeological potential of the research area; reconstruct a diachronic socio-economic and cultural history; and establish the history and development of ironworking technology in Nkansi District in particular, and southwestern Tanzania in general.

Archaeological Potential of Nkansi District. Although relatively rich in ethnography (Greig 1937; Wise 1958; Wembah-Rashid 1969; Willis 1966, 1968, 1981; Wright 1982, 1985; and Barndon 1992), Nkansi District was archaeologically unexplored prior to this research project. A few archaeological research projects, however, had been conducted in the neighboring area. These include Brian Fagan's and John Yellen's 1966 excavations at the Ivuna salt-processing site, 15 km southwest of Lake Rukwa (Fagan and Yellen 1968), Desmond Clark's excavations in the early 1960s at Kalambo, along the border of Tanzania and Zambia (Clark 1969, 1974), and Pamela Willoughby's survey and test excavations along the Lake Rukwa trough (Willoughby 1990). With the exception of Willoughby's surveys, the others were spatially restrictive, leaving the Fipa plateau and the shore of Lake Tanganyika north of Kalambo Falls completely unexplored.

Diachronic Culture History. Although the southeastern shore of Lake Tanganyika and its hinterland are rich in ethnographic and recent historical information (Wilson 1958; Willis 1968, 1976, 1981; Tambila 1981; Wright 1982; Barndon

1992), questions related to the earlier history of modern and recent Fipa socioculture as expressed, for example, in the ironworking technology, settlement styles, farming and other sociocultural variables, have only been superficially investigated by these studies. Additionally, there is a fifteen-century information gap between the linguistic evidence from around the beginning of the first millennium A.D and the ethnographic and historical evidence beginning from 1700 A.D.

This work provides a socio-economic and culture history of Nkansi District in particular and southwestern Tanzania in general from the Early Iron Age to the present. It uses archaeological, oral, and literary information to explain the peopling of the area, settlement, economy, iron technology and its socio-economic contribution to the society, as well as placing the culture and traditions of southwestern Tanzania in a regional (East and Central Africa) and continental perspective.

History and Development of Ironworking. This study examines the historical development of ironworking technology by using a diachronic and multivariate approach. It examines and interprets intra-regional and intra-technological variations and looks at ironworking within its cultural settings. The field research in Nkansi District revealed three different types of bloomery[7] technologies: katukutu, malungu and "Barongo" type. The first (katukutu) involved a single process of bloom

[7] Bloomery technology refers to "a variety of iron smelting process in which ore is reduced to metal predominantly in the solid state at a relatively low temperature." (Miller and van der Merwe 1994:33).

production in short (0.7-1.2 m) globular, natural-draft furnaces with multiple (8) tuyere ports; the second (malungu) involved the production of bloom in two stages, smelting and refining, each of which used different types of furnaces. Smelting was conducted in tall (2-3.5 m), shaft furnaces with ten tuyere ports and a natural-draft mode of combustion, while refining was carried out in small (0.3-4 m) furnaces with three tuyere ports worked by bellows. The last ("Barongo") technology employed low shaft furnaces made of slabs from termite mounds. Similar to the malungu technology, the Barongo type technology involved smelting and refining as separate processes.

In addition to the technological attributes, the three technologies varied in spatial and temporal distribution. The katukutu technology dated between 1500 and 1800 A.D. and was located along the shore of Lake Tanganyika and on the escarpment; the malungu technology dated between 1850 and 1930 A.D. and was located mainly on the Fipa plateau and on the escarpment; and Barongo type technology dated to the nineteenth century and was located along the shore.

This study examines each of the three technologies separately to establish factors that favored their historical development, sociocultural contributions, and ritual and technological expression. It also unravels technological, sociocultural, and chronological relationships found between these technologies.

Theoretical Orientation

I have argued elsewhere (Mapunda 1991a) that the role of any academic discipline, be it physical science or behavioral science, won't be complete without taking into account its potential contribution towards solving development problems faced by the local populations in the research location. Arguing along the same line of thought, Sinclair et al. (1993) state that "archaeology is one means of collection, interpretation and transmission of historical information in specific social contexts and not merely a way of accumulating knowledge of past human behaviour" (Sinclair et al. 1993:428; see also Shanks and Tilley 1987).

To achieve the social goals of archaeology, a researcher needs to answer several fundamental questions in the course of her or his project. These include,

> What is the object of study? For whom? What emphasis should be placed on which set of meanings embedded in material culture? How should the work be implemented--mass involvement or small, highly trained technical teams? Should research be oriented academically towards theoretical advances or should resources be redirected to convey an awareness of the existence and characteristics of the precolonial past to ... peasants and workers? (Sinclair et al. 1993:428).

These are important questions because they guide one towards determining methodology, interpretation, and information presentation (writing). However, in the case of Africa, it is also important to distinguish between foreign and national research workers. Our perspectives and goals differ (or need to differ) and so do the answers to the questions listed

above. For example, an indigenous African researcher influenced by historical (e.g., the need to correct the colonial historiography) and economic prioritization (due to the meager resources most countries have) will more likely be socially oriented toward justifying her/his course and buying acceptance into the society to which she/he belongs. These are not necessarily fundamental problems for a foreign researcher; a concentration on epistemology (theory and method) can be satisfactory by itself.

This study was conceived, conducted, and is presented here for the purpose of reconstructing the history of the people with whom I belong, therefore, my own history lost both with the passage of time and through purposeful distortion to suit past socio-political goals. In searching for information, the research goals mentioned above were used as general guidelines. Both formal and informal opportunities were opened to the local people in the research area to influence my methodology and interpretations in the manner which we all believed represented the 'right' history. Emphasis was and is given to questions most important to the history of the indigenous people.

Economically, this research (and other research projects that deal with pre-industrial iron technology in Africa) has the potential to encourage the development of iron-smithing which, especially in rural areas, supplements the unstable commercial industrial sector. Local iron smiths produce and maintain various local implements such as hoes, bush-knives, buckets, metal cooking pots and many others at a low cost affordable by

the rural, low income residents (see also Wright (1985) and Kapinga (1990) for this view).

Dissertation Coverage

The dissertation is divided into eight chapters. The second chapter provides a description of the physical and social background of the research area. This is meant to provide a spatial context for the study, as well as to set out a background upon which a wider, trans-regional, techno-cultural comparison can be made. By providing the spatial and socio-cultural background, the chapter justifies field methods and techniques applied during the field project.

Chapter 3 presents a literature review of the historical development of iron technology at the global, continental, regional and local levels. Emphasis, however, is given to studies conducted within and close to Ufipa with a view of isolating some of the technological, socio-cultural, and environmental factors that might have influenced some patterns of adaptation in Ufipa, such as the spread of knowledge of iron metallurgy, population dynamics, and settlement.

The field methods and techniques employed during ethnographic studies, site survey, excavations, and microscopic analyses are dealt with in the fourth chapter. This chapter also accounts for the selection of archaeological methods and techniques. Sampling strategies for research localities, areas to survey, sites selected for excavation, and materials for chemical and metallographic analyses are also discussed.

The following three chapters (5, 6, and 7) are more focused in their coverage. They deal principally with evidence for ironworking in Nkansi District. Chapter 5 focuses on ethnographic evidence and surface occurrence of archaeological materials. Chapter 6 provides evidence from excavations, and chapter 7 presents evidence from metallographic and elemental analyses of iron ore, slag, bloom, and metal artifacts.

The last chapter (8) provides a summary based on the objective of the research project. It revisits important questions addressed in previous chapters and provides clarification and conclusions on controversial issues. These include archaeological potential, peopling, history of iron production, and interpretation of technological variations. Finally, it offers suggestions for future research based on the success and failures of this research project.

CHAPTER 2

PHYSICAL AND SOCIO-CULTURAL BACKGROUND

In this chapter I present an overview of the physiographic, climatic, and biological environment, as well as the socio-cultural background of the research area. The aim here is to provide the context needed to better understand the materials discussed in the subsequent chapters.

Physical Environment

Location

The field research was conducted in the Rukwa Region, southwestern Tanzania. The Rukwa Region is located between latitudes 5 and 9 south and longitudes 30 and 33 east. To the north the region is bound by Kigoma and Tabora Regions, to the east by Mbeya Region, to the south by Zambia, and to the west it shares Lake Tanganyika with Zaire (Fig. 1.1). The region is comprised of three districts: Sumbawanga in the south, Nkansi in the center, and Mpanda in the north. Of these districts, this field research was concentrated mostly in the Nkansi District. For this reason, the discussion below focuses more on this district than the other two districts or the region in general.

Physiography

Physiographically, Nkansi District is divided into three major zones: the Lake Tanganyika shore, the Fipa plateau, and the escarpment between the lake and the plateau. Lake Tanganyika, 670 km long and on the average 50 km wide, belongs to a series of five lakes (Rukwa, Kivu, Edward (Idi Amin), and Albert (Mobutu)) formed in the western branch of the Great Rift System. At 773 meters above sea level and with a depth of 1470 m, Tanganyika is the second deepest lake in the world--exceeded only by Lake Baikal (Grove 1986; Ntakimazi 1992).

The water level, however, has been changing throughout its six million year-history (Michel et al. 1992). During the late Pleistocene and the Holocene, for example, Lake Tanganyika, as well as other lakes in East Africa (Street and Grove 1976; Habeyan and Hecky 1987; Davison 1991), witnessed at least seven high water levels and six corresponding low water levels. High water levels have been recorded around 35,000 B.P. (with a rise of around 100 m), 20, 000 B.P., 11,000 B.P., 2500 B.P., 1,000, 500 B.P. and in the 1980s. Low water levels have been recorded for around 25, 000 B.P. (with a record of about 600 m below the current level), 15,000 B.P., 5,000 B.P., 1,500 B.P., 750 B.P., and 250 B.P. (Livingstone 1965; Street and Grove 1976; Haberyan and Hecky 1987; Scholz and Rosendahl 1988; Davison 1991; Ntakimazi 1992). These variations were primarily related to changes in climate, although tectonic factors also contributed (Scholz and Rosendahl 1988). The Holocene

fluctuations in Lake Tanganyika were low in actual measurement, ranging between 0.5-2 m. However, they had great impact in land-use pattern along the shore (D.D.Y. 1957; see details in chapters 5 & 6).

The shoreline is generally straight and has very few natural harbors. It is bound by precipitous scarps in most places which often rise straight from the water. The scarps are interrupted in a few places, however, by gently sloping plains formed by rivers that originate from the plateau or by streams rising in the scarp itself. Good examples of such plains in Nkansi District include Kirando[1] and Kala (Fig. 1.2) which were intensively investigated during the current field research.

Kirando plain incorporates four rivers: from north to south they are Malembwe, Kavunja, Mkamba, and Luafi (Fig. 2.1). The Kavunja and the Luafi rivers are perennial, whereas the Malembwe and the Mkamba are seasonal. They all become completely dry during the last two-to-three months of the dry season (August-October). The plain extends about 15 km inland before it reaches the 900 m contour which marks the base of a series of hills and the beginning of the escarpment. These hills include: Chongo and Wangubo to the north, Chabya and Mosi-wa-Mpepo to the east, and Nkanga to the south (Fig. 2.1).

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[1] Kirando plain comprises of several settlement clusters including: Mtakuja, Kamwanda, Itete,Mabatini, Katete, Mpata, Katongolo, Jiwenikamba, Masolo and Kipili--a well protected bay. Before villagization (1974) there were more clusters and smaller in population than today.

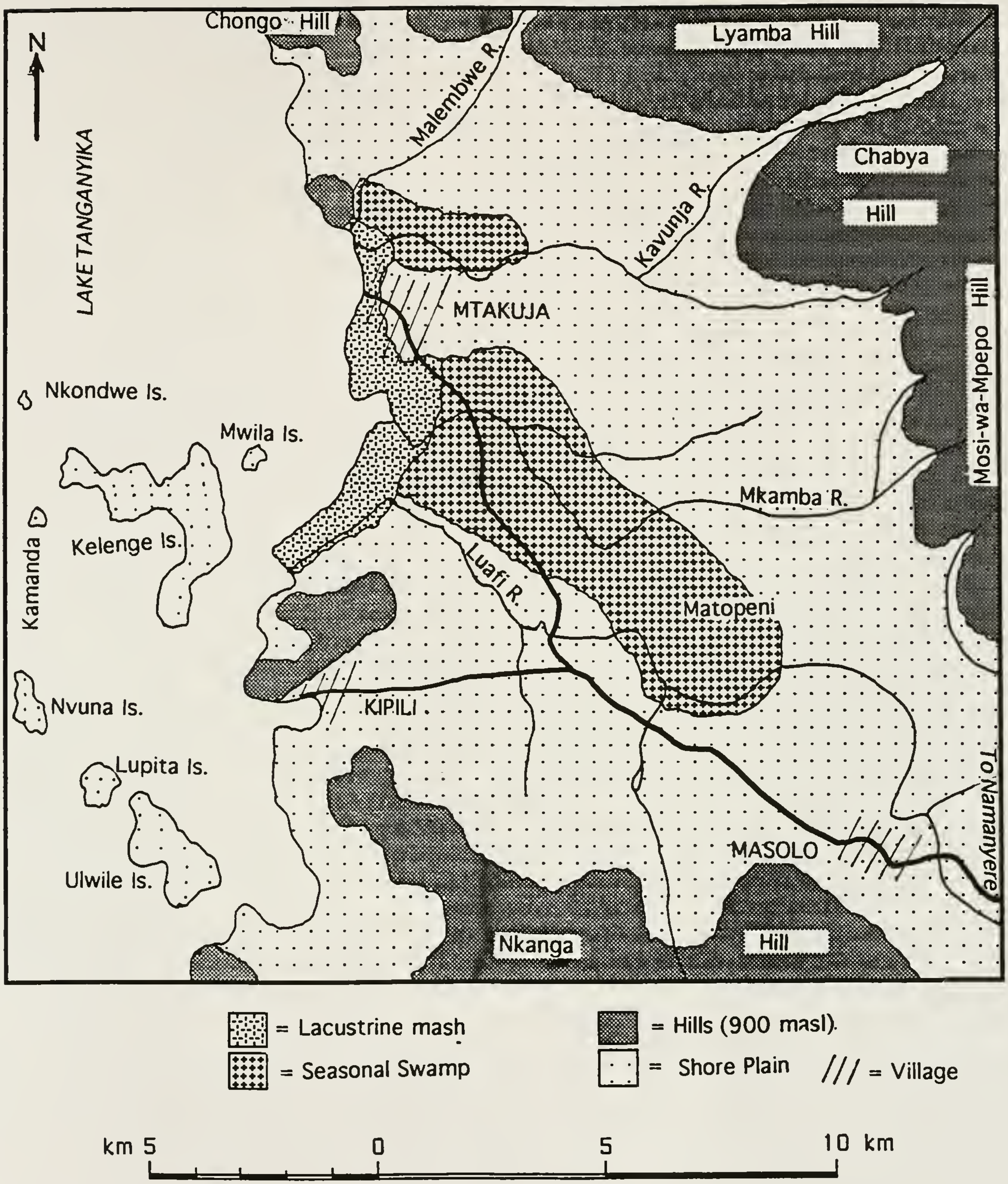

Fig. 2.1 Kirando eco-zones

Off the lake shore, there are seven islands, Kerenge, Ulwile[2], Nvuna, Lupita, Nkondwe, Kamanda, and Mwila. They range in size from less than 0.2 km^2 (e.g., Nkondwe and Kamanda) to about 2.5 km^2 (e.g., Ulwile). The islands command a strategic position both for fishing and defense (in the past). Only the larger islands, Kerenge and Ulwile, are permanently inhabited because they have deep, cultivable soils. The smaller islands are rocky and are used mainly as seasonal fishing camps.

Kala is a natural harbor, protected by two islands, Kala and Mikongolo (Fig. 2.2). Unlike Kirando which has a wide shore plain, Kala has a narrow shore plain about one km wide and is crossed by one perennial river, the Mwiu.

The escarpment is generally precipitous. In some places, however, it forms relatively wide, up to five km, terraces that accommodate small clusters of settlements. One example is King'ombe, a locality of the current research, located ten km. east of Kala (Fig. 2.2).

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2 In some literature the names Kerenge and Ulwile are prefixed by "Manda" i.e., "Manda Kerenge" or "Manda Ulwile". This prefix has been omitted throughout this work because the word "manda" means "island" in Kifipa (e.g., Kamanda -- a name of one of the islands--means "a small island"). Thus saying "Manda Kerenge island" is not only redundant but also does not make sense since the other islands are not prefixed. The nomenclature followed in here is adopted from the current usage by local people.

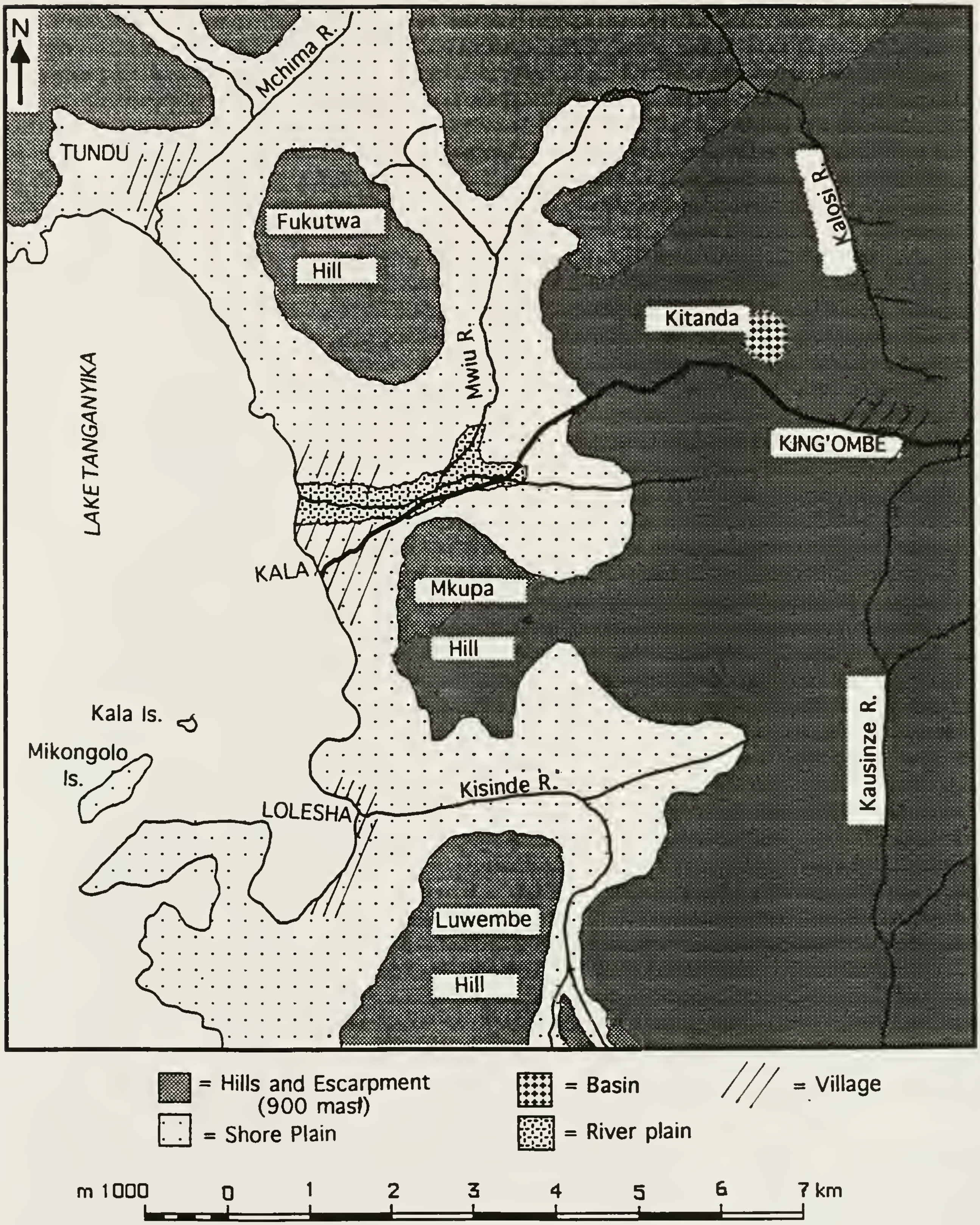

Fig 2.2 Kala and King'ombe eco-zones.

Fig. 2.3 Trough east of Kalundi Village (seen on the left) and Lusembwa Ridge (seen on the Background).

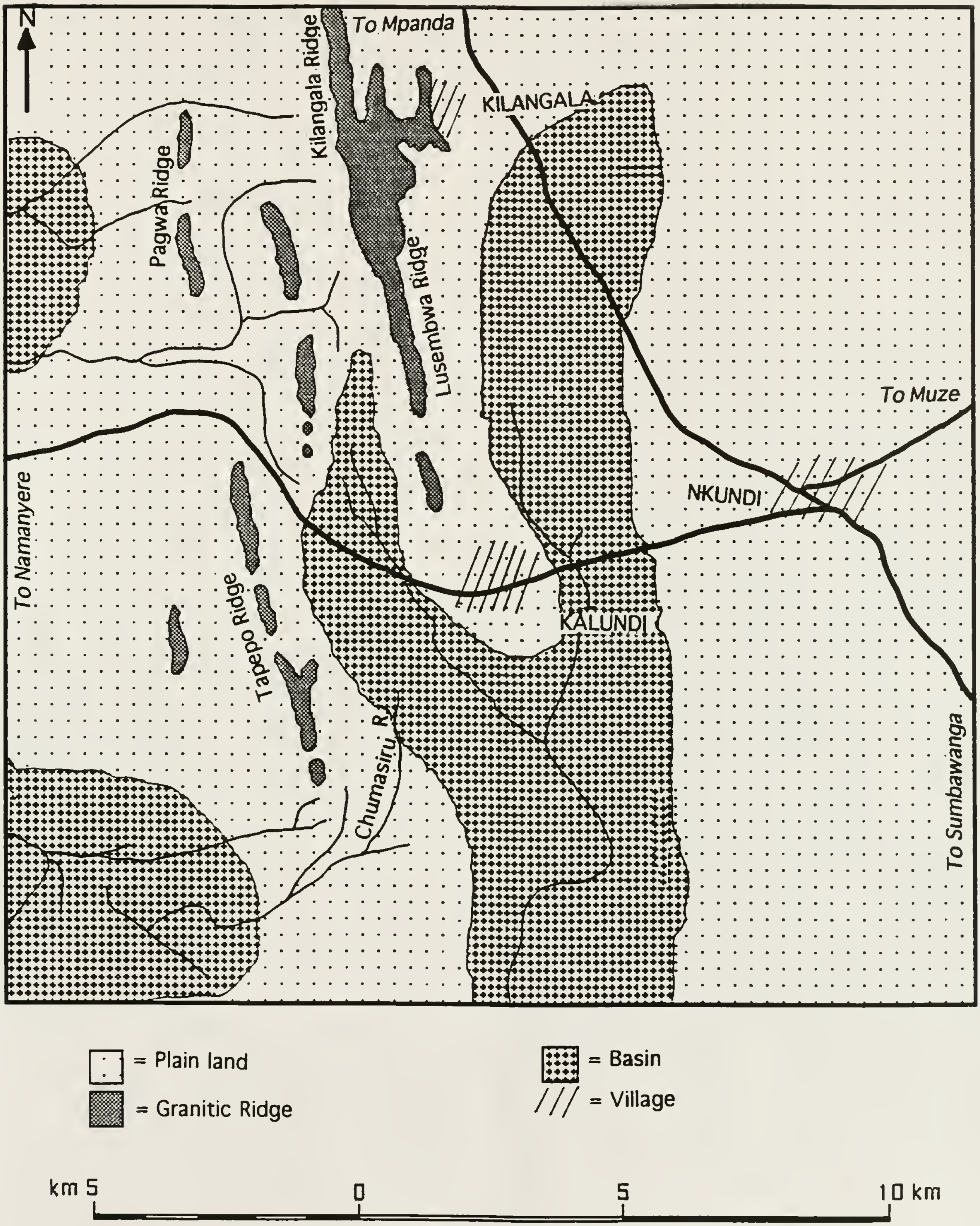

Fig. 2.4 Kalundi: Eco-zones

The Fipa plateau, averaging 2000 m above see level (masl), and 80 km wide, is concave in shape. The center is composed of open rolling country comprised of ridges and basins (Fig. 2.3 and 2.4), most of which retain water throughout the year. On the eastern side, the Fipa plateau falls to the Lake Rukwa valley at 900 meters above sea level.

Another important physiographic feature, especially in relation to this research, is termitaries. They (averaging 3 m in height and 9 m in basal diameter) are found in large numbers in all three physiographic regions. The highest concentration recorded during this field research is 22 termitaries per hectare. The common species include Macrotermes falciger, found mainly along the shore and M. natalensis, prevalent on the Fipa plateau. In Ufipa (as in other parts of Africa (Childs 1986; Killick 1990; Roberts 1993; Agorsah 1994)), termitaries are associated with various symbolic roles related to healing, magic, and beliefs as will be demonstrated in chapters 5 and 6. Recent studies have shown that Macrotermes falciger are major agents of terrestrial sedimentation especially "in African savanna and rain-forest areas, both within the African Rift System and in epeirogenic basins" (Crossley 1986). In a study conducted in the Karonga section of the Malawi Rift Valley, Crossley, has observed that a vertical transfer of sediment by Macrotermes falciger, at an estimated rate of 0.24 mm / yr, has resulted in a "homogeneous red clayey sand sheets, averaging 5 m thick, [covering] a discontinuous area totaling 8800 km^2" (Crossley 1986:191). Crossley also reports that similar effects

have been observed along the northeastern shore of Lake Tanganyika (around Kigoma). And in chapters 5 and 6 I report that Macrotermes falciger have been burying archaeological sites along the Kirando plain at a rate of 0.8 mm /yr.

Geomorphology and Geology

Nkansi District, and the whole of Ufipa[3], lies at the confluence of the eastern and western branches of the Great Rift System which, in total, runs for over 7000 km from the lower Zambezi basin in Mozambique to the Jordan valley in the eastern Mediterranean. This area of the rift confluence, sometimes referred to as the "Nyasa-Tanganyika corridor"[4], has been subjected to great tectonic upheavals. Consequently, remarkable geomorphological features have been formed including rifts, rift lakes (e.g., Nyasa, Rukwa and Tanganyika), volcanic cones (e.g. Mt. Rungwe in Mbeya Region), crater lakes (Masoko and Wentzel Heckman in Mbeya Region), and block mountains (e.g., the Fipa plateau). Geo-historic studies indicate

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3 The term "Ufipa" is derived from ifipa which means "escarpments" in the local language, iciFipa. (Willis 1981). Literally, Ufipa means "land of escarpments", referring to the escarpments that surround the Fipa plateau. In this work the word "Ufipa" is used synonymously with "Fipaland" to mean not strictly the land inhabited by the Fipa, but rather the shore and the plateau in both Sumbawanga and Nkansi Districts. This, therefore, includes Ulungu.

4 "Corridor" because the area looks like a pass-way on maps between lakes Nyasa to the south, and Tanganyika to the north. Today this area falls within three countries, Tanzania, Malawi and Zambia (Fig. 1.1). Some historians and archaeologists (e.g., Clark 1974; Barndon 1992) believe that some social and cultural transmission between northeastern and central and southern Africa took place through this area.

that the northern part of the system, which includes the Eastern Branch from north of Mt. Rungwe, is the outcome of late Cenozoic rift faulting. The relief of the southernmost part including Lakes Nyasa, Tanganyika, and Rukwa is associated with much older dislocations which took place during the Karroo geologic formations of the early Mesozoic era, 270-160 million years ago (Grove 1986).

The rift floors in the "corridor" region, as well as lakes Nyasa, Tanganyika and Rukwa, are made up of Karroo stratae overlaid with sediments derived later during Late Mesozoic and Cenozoic eras from Karroo rocks left upstanding when faulting took place. Grove notes that during the Jurassic period, when the proto-Zambezi, proto-Limpopo and Indian Ocean were formed, "the tributaries of the proto-Zambezi excavated the Malawi [Nyasa], Rukwa and Tanganyika valleys, and in these troughs Cretaceous and Cenozoic sediments accumulated and still remain" (Grove 1986:9).

Fault dislocations corresponding to some degree with the ancient dislocations have continued into the present. As a result the rifts have deepened, the floors of Lakes Tanganyika and Nyasa have subdivided into distinctive basins--each about 20 km long and 40 km wide--, and the Lake Rukwa trough has been rejuvenated (Rosendahl <u>et al.</u> 1986; Grove 1986). Seismic movements are still common in the area. The western side of the "corridor", for example, ranks second in seismic intensity in East and Central Africa, exceeded only by the region near Mt. Kilimanjaro (Moffett 1958; Gilder 1985).

Geologically, Nkansi District and Rukwa Region are relatively complex, comprised of at least six orogenic systems (Fig. 2.5). The escarpments and the shore of Lake Tanganyika in both Nkansi and Sumbawanga Districts consist mainly of plutonic rocks (intrusive granite), sometimes known as Mobilized Granite (1, in Fig. 2.5). The rocks are probably contemporaneous with the Nyanzian system which dates over 500 million years.

Most of the plateau and the area north of Lake Rukwa belong to the Ubendian rock formation, consisting of complex, high-grade, strongly-folded metamorphic rocks and intrusive granites (2, in Fig. 2.5). The rocks are mostly pelitic and volcanic in origin (Temple 1972). The metamorphic rocks are composed mainly of non-porphyritic gneiss which, according to Parkinson (1932), can further be subdivided into aplitic gneiss and "Rukwa gneiss". The former (aplitic gneiss) is older and has a low percentage of ferro-magnesian minerals and a high percentage of microcline (a potassium feldspar), acid plagioclase feldspars and pink garnet. The latter ("Rukwa Gneiss") has a high percentage of ferro-magnesian minerals, biotite, red phenocrysts of feldspar, rare occurrences of microcline, and accessory minerals which include hornblende, epidote, and apatite. The rock was folded and largely metamorphosed around 2100-1950 million years ago.

The west-central part of Mpanda District consists of a thin (less than ten km wide) band of Karagwe-Ankolean rock type (3, in Fig. 2.5) of the early Proterozoic. The formation is

largely argillaceous and has been mildly metamorphosed to phyllites, argillites, and low-grade sericitic schists, while arenaceous formations have been changed to quartzite. The system was folded and metamorphosed some 1300-1100 million years ago though post-tectonic events may be as young as 850 million years (Temple 1972).

The Bukoban rock system (4, in Fig. 2.5) occupies much of northwestern part of the region through the center of Mpanda District and the southwestern corner of the region. The system is characterized by conglomerates, thick-bedded sandstones, red shales, quartzite, dolomitic limestones, and extensive flows of basalt. It is predominantly terrestrial and volcanic, slightly-folded, considerably faulted, and virtually unmetamorphosed.

The Kirando plain in central-western Nkansi District, and the north-eastern part of the District consist of the Karroo rocks (5, in Fig. 2.5), dated to 270-160 million years. These are principally terrestrial sediments, consisting of sandstones, conglomerates, tillites, shales, red and gray mudstone, and limestone. Geo-historically, Karroo rocks were laid down in downfaulted or downwarped areas and have been preserved. The Karoo series, though generally easily eroded, have been preserved because they occupy structural basins (e.g., Kirando). The Karroo formations are the oldest containing uncontested plant and animal remains (Survey Division 1956; Temple 1972).

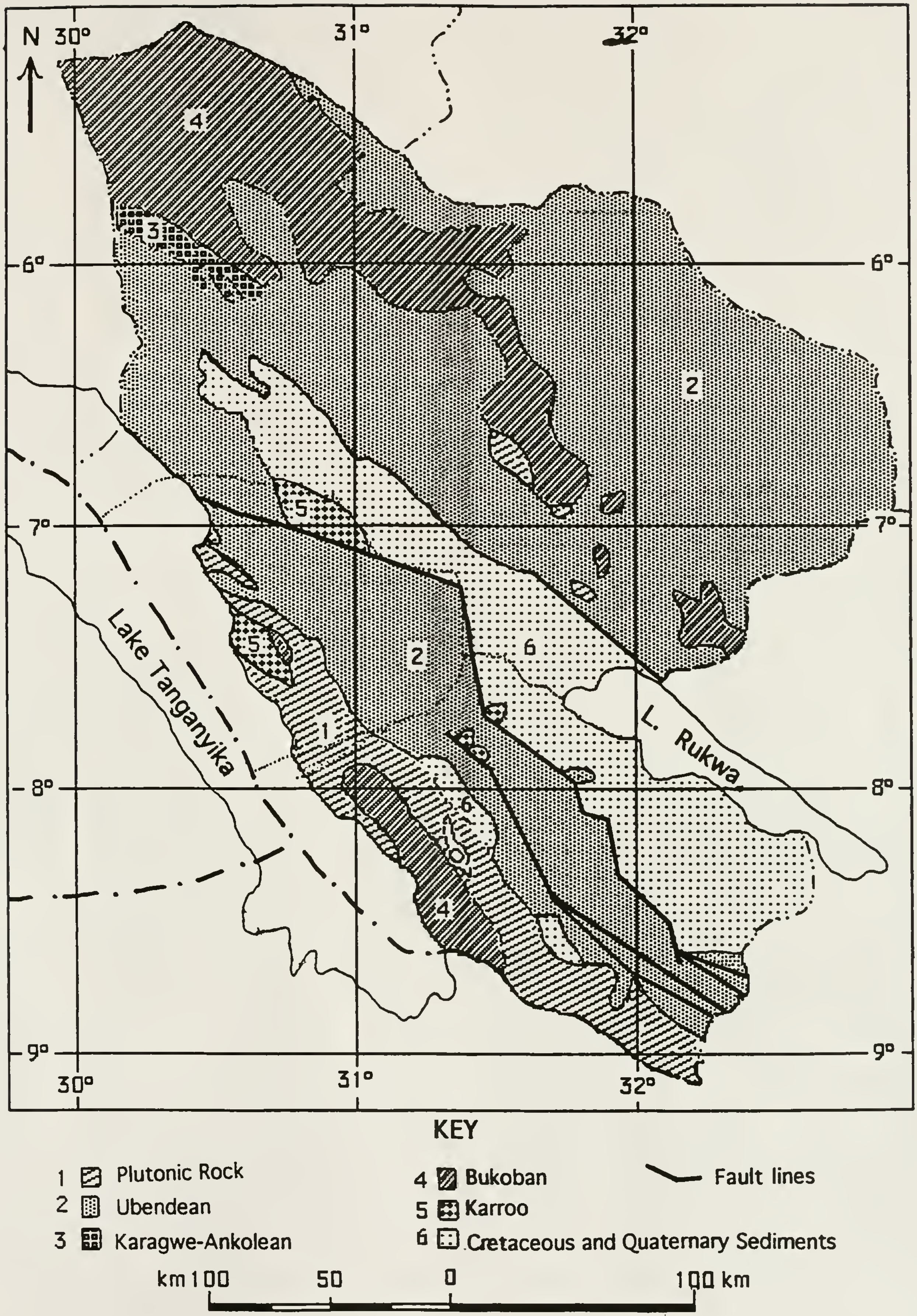

Fig. 2.5 A Geologic Map of Rukwa Region (modified from Survey Division 1956 and Temple 1972)

The Lake Rukwa trough and some parts of the plateau west of Sumbawanga consist of young (Cretaceous to Quaternary) terrestrial deposits of various kinds (6, in Fig. 2.5). It should be noted that alluvium deposition along the shore of Lake Tanganyika is relatively low[5]. This is because of low rainfall amount (750-1000 mm), limited catchment area of the affluent rivers (60 km maximum length), and the hard parent rocks--crystalline metamorphic and igneous rocks (Yuretich 1982; Grove 1986; Haberyan and Hecky 1987).

The bases of the troughs on the plateau are formed of laterite, some of which are rich in iron. For a number of centuries, they have served as sources of bog ore (limonite) for indigenous iron smelters in the area. A good example is a 4 X 1 km basin west of Kalundi village, a locality of the current research, located 40 km northwest of Sumbawanga (Fig. 2.4). Small amounts of non-ferrous ores, namely lead, copper, silver and gold as well as precious stones e.g., garnet, are reported from all over the Rukwa Region. None of them is present in any commercial quantity. The only commercial mining in the region, but now closed due to exhaustion, involved lead, copper, silver and gold in the 1950s at Uruwira, in Mpanda District (Moffett 1958).

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5 Carbon-dated sediments from a core from the southern part of the lake yielded sedimentation rates on the order of 1 mm/year (Haberyan and Hecky 1987) (compare, for example, with 1-3 mm/ yr in Lake Turkana (Yuretich 1982)).

Climate

Nkansi District and Ufipa in general, receive moderate mean annual rainfall, between 750-1000 mm that spread over the months from December to May. The heaviest rain usually occurs between January and March. The escarpment gets more rain than the lake shore or the plateau due both to relief and vegetation cover (as elaborated under Flora below).

The plateau is generally cool throughout the year with July being the coldest month (15 °C) and November the warmest month (21 °C). The mountain tops may record temperatures as low as 4° C in July. The shore, on the other hand, is hot (25 °C) and humid during the rainy season but for the greater part of the year the proximity of the lake has a cooling and stabilizing effect and the daily variation in temperature is rarely more than five degrees centigrade (Moffett 1958).

During the dry season, July-October, the plateau receives strong easterly and southeasterly winds. The Lake Tanganyika shore is generally protected from the strong winds by the plateau. It instead gets cool off-lake winds, especially at night.

Flora

The shore is characterized by grassland interspaced with Miombo (Brachystegia) woodland. Grass formations occur on the wider shores and lacustrine swamps. Such localities include Kabwe, Kirando, Wampembe, and Kala. A few areas, especially

the top of precipitous or "sacred"[6] hills, have retained clusters of wood. The dominant species in such stands[7] include Brachystegia spiciformis and Albizia antunesiana with a community dominance index of 62.4% (Kikula 1979). Other species in the area include Pterocarpus angolensis, Diplorynchus condylocampon, Trichilia emetica, Brachystegia allenii, Julbernardia globiflora and Brachystegia bussei, while Diplorynchus condylocarpon forms the main shrubs species of the underground layer (Kikula 1979).

Both the escarpments and hills east of the shore are the most wooded eco-zones in the district because the steep relief obstructs easy accessibility and so checks human effects through farming or timber sawing. These are two of the three most destructive means of deforestation in the area, with the other being bush-fires. Some of the woodland is under Government reserve. The dominant tree species on the escarpment[8] include Brachystegia spiciformis and Acacia spp. with a community dominance index of 70.3%. Other species include Brachystegia microphylla, Brachystegia bussei, Cussonia arborea, Bridelia carthartica, Sterculia quinquiloba, Grewia sp., Pericopsis angolensis, Diospyros mespiliformis, Dracaena spp.

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6 Some hills in the past were highly respected because the local people believed that "Miao" messengers of God (Leza) lived on them. Several taboos surrounded them, including burning them, hunting, cutting trees, cultivating, and sometimes even passing (walking) through them. Only selected members of the society were allowed go there to offer sacrifices and communicate with the "Miao" on behalf of their communities. An example of such a hill is Nswa, north of Kirando.

7 A case study from Kirando and Kipili (Kikula 1979)

8 A case study from Kankwale (Kikula 1979).

and Selerocarya caffra. Most trees, however, are short with small mean basal area so that the stand resembles a regenerating woodland (Kikula 1979).

The plateau is generally treeless, dominated by grass. The main grasses of the plateau are Hyparrhenia spp., Laudetia spp., Setaria and some Themeda spp. (Kikula 1979). The margins of large rivers, and tips of precipitous or "sacred" hills are characterized by mosaic evergreen forest stands which, in most cases, lack a transition vegetation with the neighboring vegetation types (grasslands). Common species of the mosaic stands include Syzigium guineense, Salacia Stuhlamaniana, and Parinari curatellifolia. The presence of mosaic forests on the plateau suggests that the area was well forested in the past. Aside from this indication, the presence of large tree stumps and stands of ferns (dominant species being Preridium acquilinum)--typical undergrowth in forested areas (Kikula 1979)--also lead to the assertion that not long ago the Fipa plateau was forested. Additionally, oral sources[9] testify that most of the region was forested even as late as the beginning of this century.

There is little doubt that the disappearance of the forests has been caused by human influence (Nyange 1993). The most probable direct causes include shifting cultivation, especially for eleusine (finger) millet which demands a fresh field every year, bush-fire, and fuel such as charcoal and wood for ironworking. Other factors, though small in scale but effective

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[9] According to Xavery Mwanakatwe--an informant at Kalundi, 1993.

in the long run, include timber sawing and the peeling of tree bark for making beehives. Both activities are species selective. Timber sawing affects mainly Brachystegia spiciformis (Mtundu), Pterocarpus angolensis (Mninga), Albizia vesicolor (Mtanga) and Sterculia quinquiloba (Mbalamwezi), whereas bark peeling affects Brachystegia manga (Myombo).

Fauna

The Fipa wilderness hosts a variety of animals, the most common of which are baboons, wild-pigs, hares, dik-dik, antelopes, variety of snakes, birds, and many members of the other animal families. The lacustrine swamps and river mouths support crocodiles and hippopotami.

Game animals such as roan antelope, hartebeest, kudu, topi, eland, bushbuck, reedbuck, duiker, buffalo, elephant and lion were commonplace on the plateau and around the northern shore area until the 1930s (Popplewell 1937). These animals migrated to the Katavi Game reserve located to the northeast, mostly in Mpanda District in the following 2-3 decades. The expulsion of game animals in the area is attributed to several factors. The most important is an increased human population which has resulted in occupying land that was vacant in the past. Also important is the increased use of rifles for hunting which, in addition to killing, tends to scare animals more than other (local) hunting techniques.[10]

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10 According to Fabian Makanta--hunter and informant 1993.

All woodland areas are infested with tsetse fly, mostly Glossina morsitans, which, in the past, made sleeping sickness endemic in the region and prohibited cattle raising (Moffett 1958). Today, cattle raising is common thanks to modern veterinary medicine and population growth which has resulted in considerable bush clearance for residence and cultivation. In the 1970s the government launched a campaign to clear bush in some places, for example Kirando, in order to create a bush/tree free belt at the bottom of the escarpment to separate the tsetse breeding habitat from residential areas. This method, which required continuous rechecking of the growing bushes, unfortunately failed to get that follow-up and died a natural death.

The lake is rich in faunal resources including about 24 cyclop species, 55 gastropod species, 14 bivalve species, 7 crab species, and around 200 fish species (Evert 1973; Michel et al. 1992). Most of these species are endemic. Michel et al. (1992) note that only four of the 171 species of cichlid fish are not endemic; all seven species of crab are endemic; and 80 percent of the molluscs are unique to this lake. This unique fauna is probably the result of a long period of isolation, phylogenitic lability of the colonizing organisms, and the absence of any periods of hypersalinity in the lake's history (Hamilton 1982; Michel et al. 1992).

Although the annual fisheries potential is estimated at 300,000 tonnes, the actual harvest is only 85,000 tonnes (Roest 1992). This is attributed to low population density along the

shore and poor infrastructure, especially roads, motor vessels, and fishing gear (Roest 1992). Lack of modern fishing equipment explains why the fishing industry is concentrated on the pelagic species such as Stolothrissa tanganicae (Dagaa), Limnothrissa miodon (Lumpu), Laciolates stappersii (Mikebuka/M'volo), and four centropomid predators of the genus Lates (Sangara), namely L. staperssii, L. microlepis, L. augustifrons, and L. Mariae. Other species found in Nkansi District include Hydrocyon lineatus (Kibebe), Alestes Marophthalmus (Manzi), Tilapia tanganicae (Ngege), Boulengerochromis Microlepis (Kuhe), Chrysichthys brachynema (Kibonde); Synodontis sp. (Ngogo), Dinotopterus cunningtoni (Singa), and Clarias mossambicua (Kambale) (Evert 1973; Roest 1992; Teophil pers. comm.[11]).

Socio-cultural Background

Population

Tables 2.1 and 2.2 present, respectively, a summary of the population figures of Rukwa Region based on the last national census in 1988 and the projected population figures of 1995 based on a growth rate of 4.3.[12] for the region. Figures for the nation (Tanzania) are also provided for comparative purposes.

[11] M. Teophil is a fisheries officer and during the time of this research (1992-3) he was stationed at Kala. I am grateful to him for information on the distribution of species in Nkansi District.

[12] The growth rate between 1967 (population 276,091) and 1978 (population 451,897) was 4.5. The current (based on the 1988 census) national growth rate is 2.8.

TABLE 2.1 Population Density of Rukwa Region by District
(Population figures based on the 1988 census: Bureau of Statistics pp. 135-140)

Location	Population	Area of land mass	Density (per sq.km)
Tanzania	23,174,336	881,289	26
Rukwa Region	694,974	68,635	10
Sumbawanga	328,312	13,417	25
Mpanda	256,487	45,843	6
Nkansi	110,175	9,385	12

TABLE 2.2 A Projected Population Density of Rukwa Region by District by 1995

Location	Population	Area of land mass	Density (per sq.km)
Tanzania	28,010,676	881,289	32
Rukwa Region	933,166	68,635	14
Sumbawanga	440,835	13,417	33
Mpanda	344,394	45,843	8
Nkansi	147,936	9,385	16

With a density of 10 people per km^2, 2.6 times smaller than (or 38% of) the national density, Rukwa region is comparatively sparsely populated. Anselm Tambila notes that the population of Rukwa has remained sparse throughout the last one century and a half. "The official figure for the year 1912/13", he notes, "gave the region, then known as Bismarckburg, a population density of 0.9 people per km^2" (Tambila 1981:15).

The population is not uniformly distributed due to the unequal distribution of natural resources, especially arable land and water. In Nkansi District, for example, about 60 percent of the population inhabit the plateau, 30 percent the lake shore; and 10 percent the terraces on the escarpments (Bureau of statistics 1988). This research demonstrates that limited arable land along the shore and lake fluctuations were the chief factors for population movements in the last 500 years (and perhaps longer) between the lake shore on the one hand and the Fipa escarpment and the plateau on the other. People migrated to the escarpment and the plateau during high water periods and returned during low waters (more information in chapter 6). These population movements created pseudo-vacancies along the shore and on the uplands which, together with trade opportunities along the shore, have attracted immigrants from the Indian Ocean littoral (Arabs) to the east and the Shinyanga and Mwanza Regions (Sukuma), as well as Rwanda/Burundi (Tutsi) to the north and Zaire (Tabwa and Goma) to the west. This is elaborated in the following sub-section.

Ethnic Groups

Today, Nkansi District is multi-ethnic. Whereas the plateau area is occupied mainly by a Fipa majority and Sukuma[13], the lake shore is inhabited by a variety of ethnic

[13] These are immigrants from Mwanza and Shinyanga Regions to the north. They are attracted to the south by pastures for their cattle and farm land. Willis (1981), however, claims to have found "Sukuma who speak a similar language to those Sukuma in Mwanza, but these came from the south, probable Zambia". I highly doubt the credibility of this account after the current research.

groups, some of them represented by less than one hundred individuals. The Fipa extend between Mkombe to the north and Kala to the south; Lungu, the second largest group, and the Mambwe live south of Wampembe; Tabwa and Goma live in the central area of the shore; Arabs are confined at Kirando; and the Sukuma occupy pastures and farmland on the peripheries[14] of villages north of Wampembe.

Before we go any further, it is important to note that the characterization given above has been simplified. Exact frontiers, both socio-cultural and linguistic, are difficult to determine. This is because, first, the people, especially on borders (e.g. Kala), speak a "Creole" type of language--in the case of Kala, for example it is the mixture of Kifipa and Kilungu. Second, some people, especially youth, tend to change ethnic identities for various reasons. During this research project, for example, we discovered (through cross-examination) over a dozen Fipa youths around Kirando who introduced themselves as Tabwa or Goma (from Zaire). This is because both Tabwa and Goma who live in Kirando today are generally economically wealthier than the Fipa. Additionally, the shore dwellers, irrespective of ethnic origin, stereotype the Fipa as conservative, superstitious and witches[15].

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[14] The Sukuma are encouraged by the village authorities to occupy the peripheries of the villages in order to keep their livestock away from the "other people's" crops.

[15] Ironically, the plateau Fipa contend that the shore dwellers, especially the Tabwa, are smart in black magic as Fr. Manyesha (1988) affirms: "Kirando ni sehemu ambayo imekuwa ikiogopwa sana kwa uchawi na watu wa nje; na hata kuwa Mnyakirando tu ni tishio kwa Wafipa wengine". (= "Kirando is a place which has

Commenting on the fluid pattern of the ethnic frontiers in the area, Tambila writes:

> There were many cases [during the last century] in which "outsiders" settled down in the region or members of one ethnic group settled on the territory of another creating a situation in which one can hardly write "tribal" histories. Such histories cannot make sense because the supposed compartmentalization is simply not there" (Tambila 1981:16)

The ethnohistory of the district can be traced back, though with some gaps along the time chart, to the beginning of the first millennium A.D. The only archaeological source in this area prior to the current work is the investigations at Kalambo Falls along the Tanzania-Zambia border by Desmond Clark and his colleagues in the 1960s (Clark 1969, 1974). The Kalambo Falls are situated on the edge of the Lake Tanganyika Rift escarpment near the southern tip of the lake at an altitude of 1,150 m (Clark 1969), about five km from Lake Tanganyika and 80 km south of Kala. Physiographically and geologically, the Kalambo Falls area is closely related to the Kirando-Kipili-Kala area, the shore localities of the current research.

The excavations at Kalambo Falls produced the most complete and stratified sequence of culture history from an Acheulian Stone Age assemblage, with a racemization estimate of around 200,000 years (Gowlett 1990) (initially dated to around 60,000 years ago, Clark 1969, 1974), to the present day. The present inhabitants of Kalambo are the Lungu, one of the

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been feared by many outsiders for witchcraft; and just being a Kirandoan is a threat to the other Fipa").

Bantu-speaking peoples of the Corridor language sub-group. Lungu oral traditions hold that Kalambo was initially inhabited by the Fipa. "If so," Clark argues, "it would seem that the Fipa must have entered the valley some time after the eleventh century, perhaps in the sixteenth century[16], since up to the earlier date, if not later, it was occupied by the makers of the Kalambo Falls Industry who, though most probably of Bantu Negroid stock, made a very different kind of pottery" (Clark 1974:1).

The Kalambo pottery dates from about 400 A.D. to about 1000 A.D. and is characterized by bowls and globular pots most of which are undecorated. Decorated pots are dominated by simple decorative techniques, such as grooving and channeling, hatching, and stamping. Additionally, false relief chevron designs are found and beveled rims, often externally thickened, are common. This pottery type is related in chronology and attributes to both the Urewe Ware (dimple-based) from the interlacustrine region and the Mwabulambo and Gokomere traditions from Malawi and Zambia to the south (Fagan and van Noten 1964; Fagan 1967; Robinson and Sandelowsky 1968; Soper 1971b, c).

Linguistic evidence (Nurse 1982; Ehret 1991) suggests that influxes of Bantu-speaking people, proto-Eastern Bantu from the Niger-Congo region, settled in the interlacustrine region (the region bounded by Lakes Victoria, Albert (Mobutu),

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[16] The current research supports the "sixteenth century" date (see chapters 6 and 8).

Edward (Idi Amin), Kivu, and Tanganyika) around 1000-700 B.C.. This group formed two offshoots, Mashariki and Kusini, between 800-400 B.C. Later, the Mashariki community split up into seven primary subgroupings: (1) Lakes; (2) Kati; (3) Upland; (4) Langi; (5) Southern Tanzania (6) Kilombero; and (7) Corridor. The Fipa, together with the [Lungu], Nyiha, Nyamwanga, and Mambwe belong to the last (Corridor) group. The Corridor group arrived in this sub-region around 0 A.D.

Ehret suggests that the southward route of the proto-Corridor Bantu-speakers was "perhaps initially along the west of Lake Tanganyika" (Ehret 1991:50). Implying that the first Bantu populations in the southeastern region of the lake came from the south or southwest. This agrees not only with Clark's suggestions but also with most oral accounts of origins given by the inhabitants of the corridor region today (Wilson 1958; Fagan and Yellen 1968; Willis 1981).

There seems to be a controversy, however, between the linguistic and archaeological evidence in regards to who were the makers of the Kalambo Falls industry. Who, in other words, inhabited the southeastern shore of the lake before the sixteenth century? According to Clark (1974), the makers of the Kalambo Falls Industry were neither Fipa nor direct ancestors of Fipa. If this is the case, who were they and what happened to the proto-Corridor Bantu-speakers who, according to Ehret, arrived in the region around 0 A.D.? Answers to these questions are provided in chapter 8.

Ethnographic evidence places the coming of both the Lungu and the Fipa between the seventeenth and eighteenth centuries A.D. Using the genealogy of the Tafuna chiefdom of the lake shore Lungu, Clark suggests that the Lungu arrived in the Kalambo region (from the southwest) in the seventeenth century (Clark 1974). Based on the genealogy of the Milansi dynasty which ruled the first chiefdom in Ufipa, Willis suggests that the Fipa migration occurred some time around 1700 A.D. The origin of the Fipa began with a man called Ntaatakwa, "the Unnamed One", who came from the southwest, near Lake Mweru, in what is now northern Zambia (Willis 1968, 1981).

The Tabwa and Goma from Zaire and the Arabs from the East coast migrated to Kirando and the neighboring villages during the last century as a result of the long distance trade between what are Unyamwezi to the north, Zaire to the west, Zambia to the south, and Uswahili (Indian Ocean littoral) to the east (Tambila 1981; Iliffe 1979). Some Wagoma came as refugees running from inter-ethnic wars in Zaire (Manyesha 1988). The remaining ethnic groups, Sukuma and Ha, are twentieth-century immigrants. The former (Sukuma) are mixed farmers and are attracted mainly by pastures, whereas the later (Ha) are retail traders who run petty shops all along the eastern shore of the lake.

It is clear from this overview that the Fipa are the most populous and have a long history in Nkansi District. For these reasons, the following discussion focuses mostly upon them.

Political Organization

The political history of the Fipa begins with the coming of Ntaatakwa, the founder of Milansi chiefdom. The oral traditions of Milansi holds that Ntaatakwa sent out his five sons to found villages and govern other parts of the country. These sons then became minor chiefs, who continued to regard the reigning chief of Milansi as their "father" (Willis 1968).

About the middle of the eighteenth century, during the reign of the third chief of Milansi, Ntseka, some 'invaders' came from the north. These people, said to be of Tutsi origin, usurped the chiefdom of Fipa, and introduced the Twa ruling dynasty which continued to rule Ufipa into the beginning of this century (Popplewell 1937; Willis 1968; Wright 1982). The Tutsi are believed to have brought with them a concept of political organization similar to that of the more northerly Bantu states of Karagwe, Buganda, Ankole, Bunyoro, and Busoga (Willis 1968).

The Tutsi kingdoms consolidated themselves and gave rise to two relatively strong chiefdoms, Nkansi (the source of the name of the District) and Lyangalile, that were stronger than others. The two states (Nkansi and Lyangalile) were in constant struggle (which, in turn, enhanced political and economic growth of the two states) throughout the late eighteenth century and much of the first half of the nineteenth century. This state of affairs was interrupted by the appearance in Ufipa of the Ngoni, a warrior people from southern Africa who rapidly overran the country in 1842. The Ngoni stayed in Ufipa for

several years, during which time the Twa chiefs and their followers are said to have taken refuge in caves. After the death of their leader, Zwangendaba, the Ngoni quarreled and split up and the different bands left Ufipa in various directions (Willis 1968, 1981).

Although the Ngoni occupation lasted less than a decade it marked a definite watershed in Fipa social and political history. The two chiefdoms began to concentrate on internal developments instead of the military struggles of the pre-Ngoni period. The defeat by Ngoni and, a few years later, by Bung forced Fipa to participate more actively in Swahili trade for the purpose of acquiring firearms (the Bung defeated them because they had firearms (Willis 1976). Their involvement in trans-continental trade easily paid them, thanks to strategic geographical location (between Unyamwezi to the north and Kazembe to the south, both important trans-continental trading centers) and abundant ivory resource. This in turn, enabled them to acquire firearms with which they conquered their neighbors and got war captives who were exchanged for more firearms and other manufactured goods (Iliffe 1979; Willis 1981; Wright 1982).

By the last quarter of the nineteenth century, Nkansi became the strongest chiefdom not only in Ufipa but all of southwestern Tanzania. Iliffe describes it as "one of the most elaborate chiefdoms", deserving to be called a state because it "was more stratified, had more precise borders, and was governed in a more strictly administrative manner than the

other polities of the plateau" (Iliffe 1979:24). Mwene (Chief) Kapufi, who reigned Nkansi for about thirty years (ca. 1860-90) made alliances with coastal traders and he is reported to have had an Arab 'prime minister' in the 1880s (Iliffe 1979)[17]. "Mwene", literally meaning "the one" or "the omnipotent", governed with the help of sub-chiefs known as "Walasi" (Mlasi, singular). By the beginning of this century, Kirando was under Mlasi Mwenekandawa (Manyesha 1988). The prosperity of this chiefdom remained uninterrupted until the coming of colonialism by the end of the nineteenth century.

Settlement Pattern

Ufipa, as many other places in Tanzania, was variably affected by the 'villagization' program of the 1970s which introduced, among other things, new settlement plans, land distribution, and land use patterns. For this reason, therefore, the contemporary settlement pattern in Ufipa is not a valid indicator of the past situation. It reflects the modern urban plans introduced by government officials.

The pre-villagization pattern is, however, reconstructible through both oral traditions and oral history. Additionally, archaeological survey can retrieve the old settlement units, most of which are today lost in the middle of the wilderness. A combination of these methods show us that the Fipa used to have compact settlement in village form. This is believed to be

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17 About ten Arab families, who claim a long history in the area, live in Kirando and Namanyere today (1994).

a long-held cultural trait (Iliffe 1979). The concentrated village settlement probably resulted from the need for a communal labor force to produce eleusine (finger) millet, their staple since time immemorial (Willis 1968; Iliffe 1979). This settlement system additionally enhanced collective defense which involved building fortifications. Nearly all pre-colonial Fipa villages were defended by stockades and sometimes by deep ditches. An excellent example of a defensive ditch is the one called Kantalamba which was dug to obstruct attacking Ngoni under Zwangendaba in the 1840s. Minor ditches, which are common all over Ufipa, were dug to keep wild-pigs away from planted fields. Villages were usually located on rising, open grounds near perennial sources of water (springs, streams, or Lake Tanganyika). Settlement pattern varied from linear to circular to amorphous, depending on the landscape (Thomson 1881; Iliffe 1979).

Although the contemporary houses are rectangular, usually with two bedrooms and a living room (a plan that G. D. Poplewell observed in the 1930s as well), traditionally both Fipa and Lungu built circular houses with conical roofs. The houses were built of poles with or without mud plastering with thatched roofs. In places where building trees were scarce, people used to recycle the old poles (also see Popplewell 1937). The house exteriors were (and some of them still are) painted in decorative designs, usually by horizontal layers of alternating colors, often red and yellow, or geometric (triangular) designs.

Farmers also build food-storage structures (barns) especially for cereals: eleusine millet on the plateau and rice along the shore. These are also constructed from wooden posts and mud.

Subsistence

The contemporary inhabitants of Nkansi District subsist on farming, herding, fishing and trade. Petty income is also earned through part-time occupations such as honey collecting, precious minerals hunting, and crafts: potting, basket and mat weaving, and iron-smithing.

Farming. Farming is Fipa's most important occupation. Some travelers who crossed Ufipa in the nineteenth century (Thomson 1881) expressed their admiration over the Fipa's farming skills and devotion to farming. Their farming technique involved the use of green manure formed into cones (Popplewell 1937; Iliffe 1979), called ituumba in Kifipa--a technique today limited to rice farming. The cones were prepared by collecting and heaping-up green grass (cleared from the field) and covering the heaps with earth. Completed cones measured about a meter high and a meter wide at the base. They were planted with eleusine millet in the first year while in the following year they were leveled and ridges were made on which maize, beans, millet, groundnuts and cassava were planted. A new plot was prepared at the same time adjacent to the old one for eleusine millet. This process continued through the third year. Thereafter, the cycle started at a new field (Popplewell 1937).

Planting and harvesting of all crops in the past was done by the women, while the preparation of the fields was shared between sexes (Popplewell 1937). We do not see this strict division of labor today.

Similar farming techniques and crops are found along the shore and on the plateau. Before the introduction of the current staple food crops, cassava and maize (from South America) and rice[18] (from Asia) around the eighteenth century, the staple crop all over Ufipa was eleusine millet -- a cereal believed to have been cultivated in the "corridor" sub-region since around 0 A.D. (Ehret 1991).

Eleusine farming technique in Ufipa is sometimes environmentally destructive, especially to trees. It involves cutting trees in new areas and burning them to ash. The farm is then hoe-ploughed and planted. Since neither manure nor chemical fertilizer are used, the crop product per unit area usually drops significantly after the exhaustion of the "ash fertilizer" and humus, often after the third or fourth consecutive harvest. Consequently, the farmer looks for a new wooded plot and the same process is repeated. This shifting technique of cultivation is employed in places where farm-land

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18 The local people hold that rice, as well as sorghum, eleusine, banana, groundnuts, and sweet potatoes are indigenous crops. This is because: (1) there are wild varieties of some of these crops. Wild rice for example still grows around Kipanga, and wild banana, known as Kulumbaleza, used to be common in forested areas on the plateau. (2) These crops have been grown in the area for years, and oral accounts give no external origin. Foreign crops for them included maize, cassava (brought by a British D.C. (District Commissioner)) from America, oil palm (brought from Ujiji), mangoes (brought by priests -- missionaries). Unfortunately the claim, especially of the wild "progenitors" was not followed-up during the current research. It is an interesting research topic for the future.

is plentiful. But where and when land is scarce, the farmers adopt crop rotation and/or field fallowing.

Farming in Nkansi District is principally for subsistence (food) rather than for commerce, but in good years (dictated by rainfall amount and distribution) farmers often manage to produce surpluses of eleusine millet, rice, maize, beans and sugarcane. With the exception of sugarcane, the rest of these crops are usually exported outside the District. The rice and beans are exported to Zaire and Burundi; while maize and eleusine millet are sent to the big towns in the north of the country.

Animal keeping. The following domestic animals are commonplace in Nkansi District: cattle, goat, sheep, donkey, pigs, dogs, chicken, ducks, and pigeon. Two species of cattle are kept: zebu, mainly by the Sukuma, and the Ankole type kept by the Fipa. The division is historical in the sense that Ankole cattle were brought into Fipaland by the Tutsi immigrants in the eighteenth century. Zebu cattle are presently being brought in by the Sukuma as they migrate from Shinyanga and Mwanza in the north following pastures and farm land.

Fishing. Fishing is still extensively practised in the lake and the perennial rivers. The chief catch in the lake is Stolothrissa tanganicae (Dagaa) and Laciolates stappersii (Mikebuka). These are caught at night using the illumination method. A kerosene pressure-lamp, fitted with reflectors to direct the light onto the water, is tied at the tip of a canoe and a bag net is laid deep underneath. Attracted by the light, the

fish accumulate under the lamp; then the fishers lift the net and haul it into the canoe. The process may be repeated as many times as the fishers find it necessary. In the past, fishers used a wood fire in place of pressure-lamps. The woods were carried on a small iron grate fixed at the front of the canoe.

Exchange. Both local and long-distance exchange networks can be traced far back in history in Ufipa. As Gray (1957) suggests and as this research illustrates (chapters 6 and 8)[19], commercial and other relationships between the Indian ocean littoral and the region around Lake Tanganyika probably existed as early as the first millennium A.D. Although there is little or no information regarding interaction between the coast and the Lake region for the following eight centuries, there can be little doubt that it continued (Gray 1957). By the nineteenth century the Fipa were directly tied into the long-distance trade network controlled by their Nyamwezi neighbors to the north (Iliffe 1979). The geographic position of Ufipa enabled the region to co-ordinate trade between the Indian Ocean littoral, the Atlantic Ocean littoral, and interior centers such as Kazembe and Katanga to the south and Unyamwezi to the north.

The prosperity of Ufipa chiefdoms, especially Nkansi and Lyangalile, owed much to this trade. The trade involved ivory, "oil of red color" (palm oil), and slaves bartered with fire arms, beads, blue cotton cloth, and some broad cloth. By the middle of

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19 Pottery with TIW attributes, faunal remains, a copper bead and an iron nail have been excavated from site, HvIk-58, located in the periphery of Kirando village. The site dates to 1040 ± 80 b.p. (calibrated to 890-1220 A.D.).

the nineteenth century, most of the trade traffic involved boating along and across Lake Tanganyika to and from Marungu (Zaire as it was known then) (Tambila 1981; Gray 1957). Some of the boats "were about six fathoms [10.8 m] long, but had no sails" (Gray 1957:229). Kirando (and to a lesser extent Kisumbi to the south) were the most important trading ports along the southeastern shore of Lake Tanganyika. Kirando's attraction was not much for the harbor[20] than it was for its fertile hinterland and relatively large population living there, comprising "up to twenty-five ethnic groups" (Tambila 1981:75). The islands at Kirando and the fact that the lake is narrow both at Kirando and Kisumbi, thus demanding only a few hours of rowing, put the two ports in a better competitive position compared to other ports.

This trade has left permanent legacies which include not only the presence of "indigenous Arabs" (as they call themselves) at Kirando, but also people who continue to barter with their neighbors across the lake (especially Burundi, and to a certain degree Zambia and Zaire). Exported goods include rice grown along the shore, beans (from the plateau), honey (from the neighboring wilderness), and dried fish (especially Dagaa). In exchange they import beer (Primus brand), construction materials (portland cement, roofing metal sheets, etc.), printed cotton cloth (Zairean vitenge), sugar, and electronics.

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20 As far as a good harbor (deep and protected) is concerned, Kirando cannot compare with Kipili, located only five kilometers to the south. But Kipili is surrounded by hills with very limited (only 0.5 X 0.5 km) arable land.

Occasional crafts. These include those trades that are performed by specialists, mostly as part-time.

Ironworking. Fipa were renown for iron smelting, using the tall, natural-draft furnaces called malungu, plus the refining furnaces called vintengwe. Since this subject is discussed at length in chapter 3, not much will be said here. Indigenous iron production in Ufipa stopped in the 1930s, mainly due to its suppression by the colonial government (Wright 1982, 1985). It was revived in the 1950s, as requested by the colonial administrators, following a decline in the supply of European hoes due to World War II. The revival lasted only for three years (Wright 1982, 1985) due to a combination of factors. Some smelters simply lacked the enthusiasm after having stopped practicing iron smelting about a decade before (Wright 1985). Others, as this research has learned, thought that the government's request was a mere trick meant to identify and, consequently, punish iron smelters. It should be remembered that two decades earlier the same government banned indigenous iron production on the pretext that it was hazardous to the environment. Those who broke this law had been caned and/or imprisoned[21].

Iron smithing, however, has survived to the present. Smiths either manufacture small tools such as knives, spear-heads, adzes, axes, and bush-knives from scrap metal or repair metal objects including hoes, cooking pots, buckets, and many

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[21] According to Xavery Mwanakatwe and Paulo Minango, both former (1930s) iron smelters from Kalundi, Fipa Plateau. Interviewed, February 24, 1993 (for more information see Appendix A).

other items. The skill is learned through apprenticeship, usually among kinfolks and often from a grandfather to a grandchild. An "outsider" can also acquire the knowledge by paying a "fee", which may be a goat, cattle, money, or labor.

Potting. This is a common specialized craft in Nkansi District. It is mainly undertaken by women, who usually learn the skill from their kinfolks (mother, aunt, sister) and friends. Potting remains a part-time activity because it does not have a predictable market although occasionally it yields attractive incomes to potters.

Basketry. Basket weaving is a men's activity. Baskets are made from a variety of materials including bamboo, palmetto, wood (twigs), palm leaves etc. Included in this group are basket traps for fishing which are made from twigs, reeds, or bamboo.

Matting. Mats are made from two different materials, and gender division is based on the type of material used. Palmetto mats (ukili/jamvi) are often woven by women, whereas reed-mats (msengele/mlago) are made by men.

Boat building. Fishers use built-up canoes--made by joining pieces of timber, as opposed to dug-out canoes which are common among other small-scale fishers in East and Central Africa. Oral accounts testify that in the past fishers used to dig out logs for canoes. The skill of boat building was brought by Wagoma from Zaire towards the end of the last century (Manyesha 1988). Boat-building became an unavoidable option as large trees became scarce along the shore. Since the nearest source of large trees was the Fipa escarpment, most of which is

precipitous, it was easier to transport timber than a ready-made canoe from there to the lake.

Other activities that fall under this category (woodcraft), but are usually performed by different specialists, include the making of mortars and pestles.

Hunting and honey collecting. Hunting used to be a very important business before the 1970s when the Government became more strict about it in a campaign to protect endangered species including rhinoceros, elephant, cheetah, and leopard. Most often hunters were honey collectors as well, the latter being a serendipitous activity. With the fall in hunting, some hunters have taken to honey collecting, and now are slowly moving away from depending on natural occurrences of beehives to the maintenance of artificial ones. The new beehives are made either from bark of some trees or from two split-open, dug-out pieces of logs.

Beliefs

The belief system of the Fipa in the past involved spirits and ancestor cults. Supernatural beings were conceived at three levels. At the top was Leza (God) the creator, with whom human beings did not communicate directly. Next in rank were Miao (Mwao, singular) who were Leza's messengers. They resided in various "hosts" including forests, islands, animals, big trees, rocks, precious pebbles, etc. Miao could communicate with some selected members of the society especially when they wanted to warn people from evils. The last level of

supernatural beings were Mizimu (ancestral spirits). These were divided into good and evil spirits. The latter were specifically referred to as Viswa (Kiswa, singular). Good spirits were believed to be people who lived and died happily, whereas Viswa were those people who were mistreated by relatives or fellow human beings during their lifetime; so, they came back to avenge. Viswa often were thought to be the source of sufferings for living people (Manyesha 1988; see also "Ritual sites", chapter 5).

Today over 70 percent of the inhabitants of Ufipa are Christians (Catholics) (Diocese of Sumbawanga 1985). The remaining are Muslims and traditionalists. Christianity was brought to Ufipa by the White Fathers missionaries who came by way of Ujiji (Popplewell 1937; Sumbawanga Diocese 1985). They built their first mission in the southeastern shore at Kirando in 1888 and at Kala in 1892. It is said that the Fipa accepted Christianity very readily. Iliffe reports that "as his subjects rapidly became a Christian people, [chief] Kilatu of Ufipa put his regalia up for sale" (Iliffe 1979:232). Although this may be an exaggeration, the argument that the Fipa were less resistant to Christianity is testified by other writers too (Popplewell 1937; Willis 1981; Manyesha 1988). Rev. J. Bertsch, in "Notes on Karema Diocese" attributes this state of affairs to the fact that:

> In Ufipa paganism was without a real link between parts of the same agglomeration or between parts of the tribe; there were neither practices nor beliefs imposed on all

> or taught by official ministers. It might be mentioned also that there were never any secret societies [like Nyao of the Cewa] which make paganism so strong in other countries of Africa (Rev. J. Bertsch, p. 68, quoted in Manyesha 1988:13).

Islam was brought by Swahili traders. According to one account collected by Fr. Manyesha, Islam in Nkansi District was brought by Mwinyi, a man from Tabora, during the reign of Mwene Kapufi (ca. 1860 and 1890). It is said that upon his arrival at Kirando, Mwinyi became a friend of Sumaili, another immigrant from Kigoma who was later converted to Islam and changed his name to Ali (Manyesha 1988). This account bears some contradictions, leading one to doubt its credibility. For example, it is very likely that Sumaili was already Muslim before he met Mwinyi or before he came to Kirando. First, the name Sumaili is very likely Islamic, rather than either Christian or indigenous Fipa; and second, the fact that Sumaili came from Kigoma around the end of the nineteenth century, a time when Islam had already began in Kigoma, suggests that he was already Muslim.

Oral traditions collected during this study, however, suggest that Islam came to Kirando through Arab (Swahili) traders some decades before Christianity, probably around the middle of the nineteenth century.

CHAPTER 3

LITERATURE REVIEW ON IRON METALLURGY IN EAST AND CENTRAL AFRICA

Students of indigenous African metallurgy have traditionally divided Africa into two sub-regions when discussing the history of metallurgy: 1) north of the Sahara desert, including the Mediterranean Sea littoral, the Nile Valley, and the Red Sea coast; and 2) south of the Sahara desert (sub-Saharan Africa), including West, East, Central and South Africa (van der Merwe 1980; Kense 1985; Miller and van der Merwe 1994). This division derives from the idea that the metallurgical history of the two sub-regions is different. For example, the north, especially Egypt (the Nile valley and the Red Sea coast), experienced an elaborate bronze technology whereas the south did not (Kense 1985). Moreover, in Egypt (and the Middle East for that matter), there was a long-delayed development of two to four millennia from the time iron smelting was first performed (ca. 5000 B.C.) to the time iron was used regularly (ca. 1000 B.C.) (Waldbaum 1980). This was largely due to the already established bronze industry which could meet all the needs as far as metal was concerned

(Sassoon 1963)[1]. In sub-Saharan Africa iron smelting began and developed spatially, as well as in complexity, without a prolonged delay (Tylecote 1975; Schmidt 1978b; Holl 1993). Finally, during the Bronze and the Iron Ages, the north was more closely linked with the rest of the Mediterranean world in culture and technology than with sub-Saharan Africa (Snodgrass 1980).

This review chapter focuses on sub-Saharan Africa. It begins with the debate about the origins of iron metallurgy in sub-Saharan Africa. This provides a background for the following general discussion that covers the spatial and temporal distribution of iron metallurgy in eastern, central, and southern Africa. The chapter ends with a review of metallurgical techniques practiced by the Fipa and their neighbors to the north, east, south and west and shows how they relate to the rest of the continent.

Origin of Iron Metallurgy in sub-Saharan Africa: Schools of Thought

The earliest archaeological iron artifacts come from the Middle East. The reported sites include Samarra in northern Iraq

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[1] Sassoon also adds that bronze, in some respects, has several advantages over iron. "Until it has been carburized and tempered," he notes, "pure wrought iron as it comes from the furnace is not harder than good quality bronze." Furthermore, bronze "can be worked cold, and it can also be cast far more easily than iron, there being a difference of over 500 degrees C. in the melting-point of bronze and iron." (Sassoon 1963: 178).

where "a four-sided instrument" about 4.3 cm long has been found in a grave and is dated to around 5000 B.C. Another early site is Tepe Sialk in northern Iran where three small, nearly spherical balls, have been found from a habitation level, dating between 4600-4100 B.C. (Waldbaum 1980).

A nickel-content analysis conducted on some of these objects to determine whether they were made from smelted or meteoritic iron[2], showed that the Samarra object was smelted and those from Tepe Sialk were meteoritic (Waldbaum 1980). Although this result indicates that iron smelting probably began seven millennia ago, the Iron Age in the Middle East did not begin until four millennia latter when iron ceased to be considered precious and became accepted as the predominant material for making tools and weapons. According to Waldbaum, "this era [the Iron Age] first reached fruition in about the 10th century B.C. in the large region stretching from Greece to the Leventine coast, around the 9th century B.C. in Mesopotamia, and somewhat later in Europe and region farther to the east" (Waldbaum 1980:82).

In Africa, the earliest iron objects are meteoritic and they come from two sites in Egypt: El Gerzeh (nine beads) and Armant (a ring) dating to between 3500-3100 B.C. (Waldbaum 1980). When it comes to smelting, the earliest incidental smelting evidence also comes from Egypt with finds from Giza

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2 Meteoritic iron has a nickel content of over five per cent (5%), whereas smelted iron, produced from terrestrial ores, contains very little nickel or usually none (Sassoon 1963).

and Abydos, dating, respectively, to the Fourth Dynasty (ca. 2565-2440 B.C.) and the Sixth Dynasty (ca. 2345-2181 B.C.) (Waldbaum 1980). Iron was not regularly produced in Egypt until the seventh century B.C. (Snodgrass 1980).

Iron smelting in sub-Saharan Africa started more than 2.5 millennia ago. The earliest evidence including furnaces, tuyeres, and slag come from Taruga (Tylecote 1975) and Nsukka (Okafor and Phillips 1992; Okafor 1993) both in Nigeria, dating to around the sixth century B.C.; Do Dimmi in Niger with a date of the mid-ninth century b.c. (Calvocoressi and David 1979), and some sites in Gabon, including Otoumbi, Moanda and Oyem, dating between the seventh and the second centuries b.c. (Schmidt et al. 1985; Clist 1989; Oslisly and Peyrot 1992; Oslisly 1993). Other early sites include Buhaya, Tanzania, dating between 500-200 B.C. (Schmidt and Childs 1985), and Meroe, Sudan, dating to 200 B.C. (Trigger 1969). There are also some early dates from Rwanda and Burundi which, if confirmed, will be the earliest in sub-Saharan Africa. These come from Gesiza, Rwanda, dating to the ninth century B.C and Miramba III, Mubuga V and Rwiyange I in Burundi, dating between the mid-fifteenth to the eighth centuries B.C. (van Grunderbeek 1992).

The question of how sub-Saharan Africa developed or acquired the knowledge of ironworking or metallurgy in the first place has existed since the time of amateur students of metallurgy--missionaries, explorers, and travelers--during the middle of the nineteenth century. Two schools of thought have

emerged: one believes in an external origin, and the second believes in local invention.

According to the external-origin school, iron metallurgy was imported into sub-Saharan Africa from the eastern Mediterranean. Different routes have been proposed from the eastern Mediterranean:[3]. 1) to Carthage, and from there, across the Sahara, to West Africa; 2) to Meroe and from there to West and East Africa; 3) to Aksum and from there to East Africa; and 4) a direct maritime route from the eastern Mediterranean to East Africa. Many, however, think that the first route is most viable (Sassoon 1963; Phillipson 1985; Miller and van der Merwe 1994). They argue that the knowledge of ironworking was brought to the western Mediterranean by Phoenician colonialists sometime after 1000 B.C. Then, by the sixth century B.C., the Berbers of north Africa, who "must have learnt the art from the Carthagians, ... were establishing themselves south of the Sahara at this time, and iron-smelting would have reached the southern side of the Sahara during the first few centuries B.C." (Sassoon 1963:179)

No evidence has been found so far that supports any of these various routes or the whole external-origin model. Nonetheless, the followers of this school hold tenaciously that "it is reasonable to believe that the knowledge of metal working was introduced to sub-Saharan Africa from outside, despite the

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[3] Discussion on this subject can be found in several sources, including Mauny (1952), Arkell (1961, 1966), Sassoon (1963), Shinnie (1966), Diop (1968), Tylecote (1975), (Posnansky 1966), Kense (1985), Kense and Okoro (1993) and Miller and van der Merwe (1994).

paucity of archaeological evidence in those areas that might have acted as conduits for the spread of this technological knowledge" (Miller and van der Merwe 1994:8). The debate to such people is, as Holl puts it, "a matter of faith" (Holl 1993:331) rather than a scientific discourse.

The crux of this school is the hypothesis that in order for the iron technology (which is a complex pyrotechnology) to develop it must be preceded by less complex, low-temperature (relative to iron smelting) pyrotechnologies such as the production of copper, lead, tin, glass, cement, and/or kiln-fired pottery and terra-cotta (Wertime 1980; Kense 1985; Kense and Okoro 1993). Iron technology would emerge from the use of iron ores as fluxes for instance in copper and lead smelting. Furthermore, copper and lead smelters would have became acquainted with kilns, bellows, and fluxes--all devices used for iron smelting. Based on this hypothesis, sub-Saharan Africa could not have invented iron technology because the sub-region does not have conclusive evidence for non-ferrous pyrotechnologies that predate iron production (Kense 1985; Phillipson 1985). In their words, Kense and Okoro writes: "The chief obstacles to accepting an indigenous origin for African iron-working include the lack of evidence for any pyrotechnologies in sub-Saharan Africa predating the beginning of iron production, the absence of cultures demonstrating a transitional state between dependence on stone and then iron for its technological basis and the fact that there has yet to be

found a site that predates the beginning of iron production in the Near East" (Kense and Okoro 1993:456).

The local invention school base their argument on several reasons. First, there is no evidence for an external source. As Andah (1979) for example argues, the most informative criterion to determine diffusion of iron technology in space would be similarities between the 'donor' and the 'recipient' technologies. But, as Schmidt observes, the ironworking of sub-Saharan Africa does not seem to have affinity with that of the eastern Mediterranean. In his words, "the technology of Kagera Region and possibly Taruga is so distinctive from what we know from Europe or the Middle East that we feel that the most reasonable hypothesis for the origins of this preheated smelting technology is an independent invention in Africa" (Schmidt 1983:434).

Second, the technological dexterity and variability demonstrated both ethnographically and archaeologically in sub-Saharan Africa have led many people (Schmidt 1981, 1983; Schmidt and Avery 1978; Okpoko 1987; David et al. 1989;) to believe that the African ironworkers must have been the authors and not mere copyists of a foreign technology. After observing the uniqueness of the Mafa iron smelting technology in North Cameroon, Nicholas David and his colleagues conclude that,

> As there is no record of such a group of techniques in use anywhere else, local invention is implied. We must admire the genius of the unknown inventor (David et al. 1989:203).

Third, some evidence for early copper working (Calvocoressi and David 1979; Grebenart 1987[4]) continues to be found which challenges the validity of the pyrotechnologic hypothesis used by the external-origin school. With this evidence, there is now "a reason to entertain an alternative hypothesis for an autochthonous iron technology in Africa", Schmidt (1983:432) argues. However, the finds referred to by Schmidt here have undergone some reassessment (Killick et al. 1988) and they are not as old as they were thought to be. Nonetheless, with 1000 B.C. being the earliest re-examined date for copper smelting, one can still say that copperworking preceded ironworking for three to four centuries when compared with the sixth-century B.C. date from Taruga and Nsukka (Tylecote 1975; Okafor and Phillips 1992; Okafor 1993).

Fourth, the universality of the pyrotechnologic hypothesis is also questioned. To apply this model in sub-Saharan Africa is, according to Diop (1974) and Andah (1979), an example of the importation of Western models which often do not work because the cultural and ecological background upon which they are founded differ with that of sub-Saharan Africa[5]. Since iron ores

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[4] Killick et al. (1988) have reexamined the Niger data and have found that unquestionable evidence for copper smelting dates to around 1000 B.C. as opposed to over 2500 B.C. reported earlier by Calvocoressi and David (1979) and Grebenart (1987).

[5] The thesis that the emergence of iron technology was preceded by copper technology is based largely on a research which T. Wertime, C. Smith, and Radomir Pleiner conducted in Iran in the 1960s (Wertime 1968). Their method of investigation included ethnographic inquiries and metallurgical experiments aimed at testing out "the thesis that iron was discovered on the course of the reduction of lead and possibly copper ores". And the result was: "All the people we talked to maintained that iron oxide was traditionally a common flux in the

are more abundant in sub-Saharan Africa and more easily recognizable than copper and tin, Andah argues that,

> iron metallurgy could have begun without passing through copper and bronze working or even preceded copper and bronze working. [Moreover,] in different parts of this region the beginnings of the Iron Age may have been characterized by the working of different forms of iron ore by different methods" [such as experimenting with meteoric iron] (Andah 1979:141).

Andah (1981) further suspects the genuineness of this model, especially in regards to its application to sub-Saharan Africa. To him this is another version of the "Hamitic myth" aimed at demonstrating the superiority of Caucasians. He protests that, "it is wrong to claim that ideas and peoples from outside, usually from the north across the Sahara, stimulated or generated most major developments pertaining to early food production or the earliest working of iron and copper [in West Africa]" (Andah 1981:593).

So, who is right and who is wrong? There is not enough evidence to allow one provide an objective answer to this question. To do that more data are needed (Okafor 1993; Holl 1993). Meanwhile we need to intensify archaeological research and metallurgical experiments aimed at understanding how iron might have been smelted initially in Africa. Attention should be directed towards understanding the cultural and ecological factors that might have played significant roles in the past to

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smelting of lead ores ... but the experiments in iron smelting were somewhat disappointing...". (Wertime 1968: 934).

cause indigenous development of iron technology in the various regions in the continents, as Okpoko proposes:

> The production of steel in sub-Saharan Africa in prehistoric times and the significance of metals and smiths in the sociopolitical and economic lives of the African peoples from ancient times call for a critical reassessment of the diffusionist theories of the beginnings of iron technology in parts of Africa... It indeed makes no sense to depend so much on dates in attempts at tracing the so called 'routes' through which the knowledge of iron smelting spread to parts of Africa. There is now need to look at the cultural environment within each society which made possible the take-off of such technology (that is, the internal demands for the iron produced; sources of the raw materials; people with skill necessary for the exploitation and refinement of the raw materials; and the type of metal-working processes which occurred in each society) (Okpoko 1987:224).

Iron Metallurgy in East and Central Africa

Early Evidence

The earliest evidence for iron smelting in East and Central Africa comes from the interlacustrine region where various metallurgical materials, including furnaces, tuyeres, slag, wood charcoal, iron ores, and iron artifacts have been found. These findings indicate that the inhabitants of the interlacustrine region, using locally available materials such as hematite and limonite ore, refractory clay, wood, and charcoal, were able to manufacture their own carbon steel beginning in the middle of

the first millennium B.C.[6] (Hiernaux and Maquet 1956; van Noten 1979, 1985; van Noten and Raymaekers 1986, 1988; Schmidt 1978a, b, 1981; van Grunderbeek 1981; Schmidt and Childs 1985).

Some other early ironworking sites have been reported throughout eastern, central, and southern Africa. Recently an ironworking locale with slag and iron objects was reported from Tchissanga, on the Congo coast, dating to the third century B.C. (Denbow 1990). At Nkese, in the western Usambara mountains of northeastern Tanzania, a furnace, slag, and tuyere fragments were found, dating to between the first and the third centuries A.D. (Schmidt 1988). Slag heaps and tuyere fragments were found at Mkiu, south of Dar es Salaam, dating to between the first and the fourth centuries A.D. (Chami 1988, 1994; Schmidt et al. 1992). Further south, in Mozambique, slag and tuyere fragments, ranging from the second to the third centuries A.D. were found at Matola, Enkwazini, Mzonjani, Silver Leaves, Eiland and Zitundi (Morais 1984; Sinclair 1991; Sinclair et al. 1993).

Several ironworking sites marked with furnace remains, tuyere fragments, slag, and small iron objects, such as rings and sections of iron rods or strips range in time from the third to the tenth centuries in Malawi (Davison-Hirschmann and Mosley 1988; Juwayeyi 1993). These sites include Nkope, Mwabulambo,

6 Some earlier dates have also been recorded in the region, for example, 1230 ± 145 bc at Rwiyange I in Burundi, 685 ± 95 bc at Gasiza I in Rwanda, and 2520 ± 100 bp at KM3 in northwestern Tanzania. Their anomaly makes their authenticity questionable. Schmidt and Childs (1985) suspect that a forest fire stratum or the use of old wood may be responsible for the first two while contamination by rodents may have affected the last one.

Kayerekere, Kamguze area, Chombe Shelf, Kasumanguwo, Ngosi, and Kaziwiziwi. Some copper and iron beads dating probably to the second century A.D. have been found at Mabveni in Zimbabwe (Huffman 1982). Large quantities of slag, bloom, and fragmentary iron tools such as a razor, spear point, a ring and thumb-piano keys, that date to the fifth century A.D. have been recovered at Kapirimbwe in Zambia (Phillipson 1968a, b). The earliest known preserved metals (iron and copper) in southern Africa have been found at Divuyu, Botswana, dating to between 550 and 730 A.D., Nqoma also in Botswana dated between 850-1090 A.D. (Denbow 1990) and Broederstrom, South Africa, dating to the fifth century A.D. (Denbow 1990).

Having seen the early evidence let us now examine how iron metallurgy became known in East and central Africa.

Origin of Ironworking in East and Central Africa

The question of the acquisition of iron metallurgy implies temporal and spatial lineality--characteristics which make it logical to begin discussions from where the oldest evidence is located. This "logical" approach has an inherent problem in that it promotes the tendency to think in terms of a single origin. This in turn leads one to the dichotomy of "inventors vis-a-vis copyists" and diffusion becomes the only explanation for change. This tendency is clearly evident when one reviews the way people have explained cultural changes in eastern, central, and southern Africa during the Iron Age (Soper 1971a, b, c; Phillipson 1977, 1985).

Scholars, for example, have traditionally begun with the interlacustrine region when dealing with the spread of iron metallurgy in sub-Equatorial Africa for that is where the earliest evidence have been found. Archaeologists have speculated over how the technology got or developed there from the time when the first evidence were found (Leakey et al. 1948; Hiernaux and Maquet 1956; Hiernaux 1959; Posnansky 1966). The most popular assumption was that the technology was brought into the interlacustrine region by Bantu-speaking people. This contributed greatly to the intensification of the search for the origins of Bantu-speakers by linguists in the 1960s and early 1970s (Guthrie 1962, 1967; Greenberg 1963, 1972; Oliver 1966; Ehret 1972). It later became accepted that Bantu-speakers originated in the Niger-Chad Basin (Ehret 1982a; 1991; Nurse 1982).

This claim, however, has not been archaeologically verified. In order for archaeologists to do so, they need to find some evidence for ironworking from along the alleged Bantu migration route, including Cameroon, Equatorial Guinea, Gabon, Central African Republic, and Zaire. But research in the area has progressed very slowly as it is "hampered by thick vegetation, erosion and the rapid deterioration of archaeological remains" (de Maret 1990:109; also see Eggert 1993).

Meanwhile archaeologists continued to use the linguists' claim untested. As late as the 1980s Schmidt argued that "the origins of iron smelting west of Lake Victoria can best be sought at the confluence of the Niger and Benue Rivers in Nigeria

approximately the region where the Taruga site is located" (Schmidt 1983:434). He came to this conclusion after observing that,

> the two areas bear technological similarities, that dating of the earliest occurrence of iron working in both regions are sequential west to east and that Taruga is in close proximity to the place of origin of Bantu speakers. [Thus] ...it is at least possible that the earliest Bantu speaking immigrants to East Africa brought with them an iron technology that employed highly advanced techniques indigenously invented in West Africa (Schmidt 1983:434).

Speculating about the origin of Urewe ware, Phillipson wrote,

> No close parallels are known for Urewe ware, but there are similarities with pottery from far to the north-west, in Chad (Soper 1971), and also with certain West African wares. It is in these northerly and westerly areas, also that we must presumably look for the origins of the Urewe groups iron-working technology (Phillipson 1985:173).

The Diffusion of Iron Technology

Before discussing the alleged diffusion of the knowledge of iron metallurgy in eastern, central, and southern Africa, it is important to clarify what entails the "Iron Age cultural package", a metaphoric concept used critically by some Iron Age archaeologists (Hall 1987) to denote a collection of cultural traits thought by early archaeologists as characteristic of Iron Age culture in Bantu-speaking Africa. The traits include Bantu-speaking people, domestication (farming and animal husbandry), "Early Iron Age" ceramics, centralized political organization,

and ironworking. This is the suite of concepts upon which the diffusion models reviewed in this chapter are based.

It should be noted that the idea of associating early ironworking with Bantu-speakers, pottery, political organization and farming has its roots in the interlacustrine region and dates back to the mid-twentieth century. As de Maret observes, "the idea of linking Dimple-Based pottery and the beginning of metallurgy to Bantu migration was Hiernaux's idea, though subsequently developed by Posnansky (1961)" (de Maret 1990:129).

Hiernaux had reason to think as he did. Being a devoted amateur archaeologist who worked in Rwanda and Burundi beginning in 1953 with the Institute for Scientific Research in Central Africa (IRSAC), Hiernaux (a medical doctor) found several ancient iron smelting sites with remains of brick furnaces and potsherds. His findings came just a few years after Mary and Louis Leakey and W. Owen had found old potsherds at Urewe to the east of Lake Victoria, some of which had a unique characteristic--a dimple in the base--hence, the label "dimple-based" (Leakey et al. 1948). From the cultural context, Leakey and her colleagues could tell that the potsherds were post-Stone Age, but they could not be more specific about their chronology. When Hiernaux examined the pottery he found in association with iron smelting materials, he recognized that they bore characteristics similar to the dimple-based pottery described by Leakey and her colleagues. "After further research", de Maret observes, "Hiernaux reached the conclusion

that this pottery belonged to the first Iron Age peoples in Rwanda and in the other regions of East Africa where it had been discovered" (de Maret 1990:128). Hiernaux also noted that the pottery appeared abruptly, which led him to believe that it must have been brought, together with iron, by immigrants who lived for a period with the 'Later Stone Age' people. Later on Hiernaux, L. Leakey, and Nenquin examined a pottery collection from Kasai, south-central Zaire and they (Hiernaux, Leakey, and Nenquin) agreed that it was dimple-based, thus extending the region covered by this tradition to a large part of Central Africa (de Maret 1990).

The name "Dimple based" was later changed to "Urewe Ware" (Posnansky 1961) after the type-site found by Leakey and her colleagues (Leakey <u>et al.</u> 1948). In addition to the dimple base, Urewe Ware is characterized by thick, beveled rims which are often incised or grooved. The ceramic forms include necked pots and shallow, hemispheric bowls, and sometimes beakers (most common in western Kenya). The pots are heavily decorated, the basic motif being parallel grooves or incised lines in horizontal bands around the shoulder and body that often incorporate circles, loops and triangles. Hatching and dots are often found on or just below the rim (Leakey <u>et al</u>. 1948; Posnansky 1961; Stewart 1993).

The "package" model gained popularity not only among archaeologists but also historians, historical linguists, and other social scientists. For almost three decades the model became the principal device for explaining apparent patterns of

cultural diffusion in eastern, central and southern Africa during the Iron Age (Huffman 1970; Soper 1971a; Phillipson 1977, 1985; Collett 1982).

Despite its popularity, the "package" model had some serious weaknesses. It took the co-existence of the cultural traits for granted, thus homogenizing the culture history of Bantu-speaking Africa. We were made to believe that the Iron Age materials found in this region were made by, as Hall puts it, "people of the same human physical type and language, with the same metallurgy, agricultural and animal husbandry" (Hall 1987:17).

The belief in the cultural package was so strong that the appearance of one trait (especially pottery) was taken uncritically as proof of the presence of the other traits. This explains the confusion which exists until today whereby the terms "Iron Age" and "iron technology" are often confusingly used as synonyms. This was roughly illustrated in chapter 1, but it will be more vividly demonstrated in the following review, where pottery, rather than metallurgical materials, is shown to have been used to trace "routes" followed by early ironworking communities.

<u>Diffusion of iron technology.</u> As soon as Leakey <u>et al.</u> (1948) and Hiernaux (1959) established that there was evidence for early ironworking in the interlacustrine region, their colleagues who were working in central and southern Africa began to postulate that iron metallurgy was introduced there by Bantu Speakers who had migrated from East Africa (Clark 1959).

Pottery, rather than iron metallurgy, was used to substantiate this argument (Soper 1971a; Phillipson 1977; Inskeep 1978). They argued that Bantu-speakers, along with their iron and pottery technologies and the domesticated cereals (eleusine, millet) and animals (sheep, goat and cattle), migrated south from the interlacustrine region via two routes. The first was directly south through eastern Zaire, reaching northern Zambia and Malawi by the second to the third centuries A.D. The dimple-based pottery, however, lost some of its characteristics on the way (including the dimple), so that the pottery variant observed in north-central Africa was different, hence labeled differently, including Mwabulambo and Kalambo (Robinson and Sandelowsky 1968; Clark 1974).

The second route was due east towards the coast before heading south. It is suggested that this route passed "through what is now central Tanzania, where Chifumbaze sites such as Lelesu have been reported [e.g. by Sutton (1968)]" (Phillipson 1985:175). The makers of the Lelesu ware then continued farther east, reaching the Indian Ocean littoral at what is today northeastern Tanzania and southeastern Kenya around 200-300 A.D. Further morphological and decorative changes occurred between Lelesu and the coast to warrant a new name, Kwale ware (Soper 1967a; 1971b, c; Collett 1985), named after a type-site in south-eastern Kenya. From this region the Bantu-speakers proceeded south.

Somewhere around the border of Tanzania and Mozambique the migrants split into two branches. One headed south to

arrive at southern Mozambique (e.g., Matola, Zitundo, and Maputo University Campus) around the third to fourth centuries A.D. (Sinclair 1991), and the second forked west, passed through the southern tip of Lake Nyasa, and settled in northwestern Mozambique and southern Malawi. The pottery tradition there has been termed as Nkope ware, after a type-site in southern Malawi.

After arriving in north-central Africa, these Bantu-speakers continued south and their pottery continued to change in morphology and decorative motifs. The southern wares include Gokomere or Ziwa in central Zambia, Toutswe and Lydenburg in Zimbabwe, and Msuluzi in South Africa.

In summary, until the mid-1980s, archaeologists and linguists (e.g., Soper 1971a, b; Robinson and Sandelowsky 1968; Robinson 1969; Ehret 1972; Clark 1974; Nurse 1982; Phillipson 1985) held that Bantu-speakers, who had the knowledge of ironworking, potting (the Early Iron Age wares) and crop and animal domestication began migrating from the interlacustrine region around the beginning of the first millennium A.D., colonized the land to the east and south, and spread the aforesaid cultural traits. The evidence for this reconstruction were two-fold: 1) stylistic affinities between Urewe Ware to the north and Kwale, Mwabulambo, Nkope and Gokomere etc. to the east and south, and 2) the relatively early dates of the interlacustrine region compared with the other sub-regions.

The over-reliance of one cultural variable (pottery) in explaining culture processes and change in Bantu-speaking

Africa (or the whole continent for that matter) tends to create superficial cultural homogeneity in the region as exemplified by the following statement: "The early iron-using communities over an enormous area of eastern and southeastern Africa show a very remarkable degree of homogeneity, to the extent that archaeologists generally attribute them to a single complex...the Chifumbaze complex" (Phillipson 1985:174-5) with the various pottery traditions regarded as facies of the complex.

Sinclair et. al. (1993) also criticize the over-dependence on pottery in the archaeology of the Bantu-speaking Africa and call for a multivariate approach:

> Traditionally, analysis in African archaeology has been defined in terms of ceramics with underlying assumptions of correlations with groups of people, as with Fagan's (1965) 'culture' or Phillipson's (1977a) 'tradition' and 'stream', and Huffman's (1980a) 'style system and facies'. ... Given improvements in our knowledge of production and usage of pottery there seems little doubt of the inadequacy of ceramic typology used in isolation for defining the limits and forms of past societies, and this is reflected in the marked reluctance to use ceramic categories as a basis of analysis by some scholars (e.g., Hall 1987). A multivariate approach to the archaeology of the farming communities of southern and eastern Africa is certainly needed (Sinclair et al. 1993:412).

In light of recent research findings from Cameroon, Gabon, Zaire, Angola, Botswana, and other countries in eastern, central, and southern Africa, there is some hope that a clearer picture of the Iron Age archaeology is near. Under the hypothesis that iron metallurgy was brought into East Africa by Bantu immigrants

from the Niger/Chad basin, one would expect to find some technological similarities between the Niger/Chad basin and the region along the alleged route of Bantu migration. For example, the closer the technology was to Taruga (the alleged technological cradle), the more similarities should be observed; and vice versa. But evidence from Gabon, Cameroon and Zaire does not comply with this reconstruction. Digombe et al. (1988:183), for example, have found that "Furnace size, pit volume, and the use of long tuyeres in Gabon distinguish this technological tradition from that of Taruga". Instead they observe that "There are apparently stronger affinities with several of the eastern technologies, such as those documented in Rwanda, Burundi, and northwestern Tanzania; particularly noteworthy are similarities in deep furnace-pit construction for draining slag and the size of the chimney in proportion to the furnace pit" (Digombe et al. 1988:183).

Furthermore, according to Digombe et al. (1988) linguistic evidence in the area attests that Bantu-speaking peoples were already living in Gabon at least by 1000 B.C. and that ironworking terms are derived from Eastern Bantu. In light of these general similarities and the linguistic construct, we are faced with the possibility of a reverse flow of iron-producing Bantu-speakers from the interlacustrine region sometime during the 1st millennium B.C. (Digombe et al. 1988).

Farther south, in western central Africa and southern Africa, linguistic and archaeological studies have also added a new dimension to our understanding of the Iron Age archaeology,

especially in regards to the introduction of iron, domesticated animals, and the interaction of the Bantu-speakers and the non-Bantu-speakers. Denbow (1990) notes that some words for cattle and milking have been found with apparent Proto-Khwe roots in the Khoe languages of northern and central Botswana, and along with a Khoe crop vocabulary among Kxoe (Khoe speakers of northeastern Namibia).

Linguistic evidence further suggests that independent Khwe pastoralism developed in the southern Angola-Botswana region prior to the expansion of Iron Age cultures (Ehret 1982b; Denbow 1986; Denbow and Campbell 1986). Likewise, ceramic studies in southern Africa indicate that the origins of the Early Iron Age in portions of South Africa should be traced to west-central Africa (Huffman 1980, 1989; Phillipson 1985) rather than to East Africa as formerly thought.

Studies on the impact of socio-cultural frontier between the Bantu-speakers and non-Bantu-speakers show that the interaction produced varied rather than similar results in space and time as previously thought. Denbow notes that,

> In the eastern half of the subcontinent it is well established that Iron Age Bantu agro-pastoralists gained a dominant position over autochthonous foragers and pastro-foragers, ultimately subjugating, absorbing, or eliminating them. In the west, different processes of interaction appear to have operated; in many regions autochthonic foraging food producers continue to coexist with, and complement, Bantu economies up to the present day (Denbow 1990:141).

Similarly, not everywhere were Bantu-speakers masters of knowledge: "Linguistic data suggest that at least some

Western Bantu goat-herders first acquired cattle and sheep from proto-Khoi or Khwe pastro-foragers during their initial expansion south of the Okavango-Zambezi rivers at the beginning of the Early Iron Age" (Denbow 1990:143).

Finally, some research conducted in East Africa also points to a need to revise the eastern Bantu migration theory or, at least, some routes. We noted earlier that Soper (1971a, b) believes that the Sandawe pottery collection (Sutton 1968) also known as Lelesu ware, is an intermediary tradition between the earlier Urewe ware and the later Kwale ware. This view, which assumes a linear transition in both time and space, is supported by the claim that Urewe ware is geographically confined to the interlacustrine region to the west, while Kwale ware is found to the east in both northeastern Tanzania and southeastern Kenya (Soper 1967a, b, 1971a, b; Collett 1985). This line of thought is too simplistic and needs review in light of some new research. According to research conducted in 1986 by the University of Dar es Salaam (Schmidt 1988), a pottery ware with strong Urewe affinities extends as far east as the Usambara mountains, a region which initially was thought to contain exclusively Kwale ware.

What lesson do we get from this, especially in regards to the linear and package models, for the diffusion of iron metallurgy? First, we learn that the models are simplistic and outdated. Second, the Iron Age culture is more complex than we tend to think. More examples of this complexity is

demonstrated in the review of metallurgical techniques covered in the next sub-section.

Ironworking Techniques Used by the Fipa Neighbors

Once established 2.5 millennia ago in east and central Africa indigenous ironworking continued until very recently. The technology began to collapse in most places during the first quarter of the twentieth century due in great part to competition from relatively cheap European metalware and scrap iron. The availability of both classes of iron increased tremendously following the commencement of colonialism. Sometimes the colonial governments deliberately repressed the indigenous technology to protect a market for the European-made products (Brock and Brock 1963; Waane 1979). In a few places, where European influence was minimal (mainly due to remoteness), indigenous iron production continued until very recently. For example, among the Tumbuka of central western Malawi (Killick 1990) and the Fipa of southwestern Tanzania (Greig 1937; Wembah-Rashid 1969; Wright 1982) local iron production continued until the 1930s, whereas the Barongo iron smelters of northwestern Tanzania continued until the early 1950s (Schmidt in press).

Due to such factors as the longevity of iron making on the continent, the durability of many materials related to iron production, such as slag, tuyeres, and furnaces, and the wide

spatial distribution of the technology, evidence of ironworking is plentiful. We observed in chapter 1 that there has been an increase in archaeological and ethnographic research on iron metallurgy in the last three decades in East and Central Africa. This has added considerably to the pool of information collected by both amateur and professional ethnographers, historians, and archaeologists since the late nineteenth century.

In this section I describe the techniques used in iron metallurgy in Ufipa and the neighboring areas. Where data allow, both archaeological and ethnographic information are presented. This is done in order to detail the ironworking technologies and techniques in the neighboring areas that can assist in interpreting the findings of this research and also help put the new findings in their appropriate cultural context.

Barongo Ironworking

The nearest iron smelters to the north of Ufipa are the Barongo, located south of Lake Victoria, in western Mwanza Region. The Barongo technology, which was still practiced until the middle of this century, appears in relatively few ethnographic and ethnoarchaeological reports (Rosemond 1943; Schmidt in press).

The Barongo smelters used furnaces made from slabs prepared from a certain "type of termites' nest which crops up like a hump about two to three feet [60-90 cm] high in miombo bush or in hard rocky clearings" (Rosemond 1943:82). The slabs measured about 45 cm wide by 60 cm high and 7.5 to 10 cm

thick. Each master smelter (mrongo) made his own furnace and did most of the jobs, including erecting the furnace. After the slabs were prepared, the mrongo erected a thatched hut (kitindi) made of a few wooden posts without walls to provide shade from the sun. A circular hole 100-120 cm in diameter was dug in the center of the hut about 30 cm deep and some medicine was buried at its center.

The mrongo then put in the hole a bedding of shoots with fresh leaves from any of the following trees: Mtungulu, Mubumbu, Mubelebele, or Mubula. This lining, according to Rosemond (1943), protected the msilo (the mixed mass of slag, charcoal, ore, and gangue) from coming in contact with the earth and adhering to it. This was followed by a layer of charcoal (prepared from Mbanga, Mkalati, or Mgando) and then ore. The slabs were then placed in an upright position, but inclined slightly inwards, around the charcoal, leaving gaps about 12.5 cm between them. Heavy stones were propped up against the outside of the slabs at the bottom of which earth was packed all round.

The mrongo then added some charcoal and placed tuyeres in the gaps between the slabs in such a way that their ends converged around a small circular space about twenty cm in diameter in which some large lumps of charcoal were placed. The gaps between the slabs were then filled with broken pieces of tuyere from previous smelts. The furnace was then charged almost to the top with a layer of ore followed by charcoal.

Finally, a mound of previous msilo was put at the top and some more charcoal. Then the smelting process began.

Air draft was manual, using twin bellows made from wood and goat skin. The process lasted for five to six hours during which the mrongo continued charging the furnace with msilo and charcoal until he considered it time to stop. The pieces of tuyeres which closed the gaps in the furnace wall and the large stones were then removed, the slabs were pushed slightly inwards, and the furnace was covered with sand and left for the night. The next morning the slabs were removed and the bloom, mixed with new msilo, revealed. This was smashed into some lumps with a heavy stone. Each lump was then pounded on a flat stone to obtain the smelted iron, while the other material from the msilo was set aside for a next smelt.

The smelted iron was then taken to the smithy which was in another hut with a large stone anvil in its center. There, the iron was heated until white hot and hammered vigorously with heavy stones. This was repeated several times until the mrongo was satisfied with the relative purity of the bloom. The furnace output from one smelting could be anything between five to twenty kilograms of iron, an equivalent of five to twenty hoes.

Bena, Pangwa and Kinga Ironworking

Ethnographic and historical information about this area is scarce and archaeological information is completely absent. John Sutton and a few history students from the University of

Dar es Salaam conducted a casual ethnographic study of ironworking in 1968 in the northeastern highlands of Lake Nyasa. The study basically involved collecting oral histories. Their report (Sutton 1969) shows that ironworking was a common practice among these peoples until the beginning of this century. The smelters used low-shaft furnaces, about a meter high and 0.8 m wide at the base operated with three pairs of bellows. Although furnaces were sometimes located close to resources such as charcoal and iron ore, this association was not consistent (as it was among the Fipa). Sutton later (1985) argued that this general lack of association of furnace and ore sources was a function of furnace size, noting that the furnaces were ten to fifteen times smaller than those from Fipaland. The raw materials needed to construct the local furnaces and the amount of ore and charcoal needed for smelting could be carried by a few people on their heads, even if the distance was uncomfortably long (sometimes it took a full day's journey from an ore source to a smelting site).

The smelters used iron-rich magnetite ore obtained from a compact, clayey subsoil usually located along river banks at selected sites (Sutton 1985). Smelting took an average of nine hours and resulted in a forgeable bloom which did not need refining.

Nyiha Ironworking

The Nyiha of Mbozi District, Mbeya Region were also skilled iron workers. They stopped making iron by the beginning

of this century "primarily because of competition with mass-produced goods, and also possibly because of governmental repression" (Brock and Brock 1963:97).

Brock's and Brock's (1963) report suggests that there were at least three technological variants in Unyiha, although their temporal sequence is unknown. The first was described in 1938 by an anonymous writer in the Mbeya District Book. This variant involved conical furnaces built of red clay. One furnace described by the reporter measured about 300 cm in height, 150 cm in diameter (approximately 475 cm in circumference), and tapered to 70 cm in diameter (about 225 in circumference) at the top. The wall thickness was uniform, about 12.5 cm. Externally, the walls were rough and untrimmed but the inner surface was well-smoothed and in parts almost glazed. It had ten openings about 10 cm in diameter at the base. The reporter hypothesizes that they were "probably connected with the ventilating system" (bellows). A well-made arch, 30 cm high, had been built into the furnace wall facing south. The furnace also had a 2.5 cm diameter peep-hole pierced through the wall 90 cm above the ground opposite the arch. The hole was at an angle and also showed signs of considerable use. On the same side as this hole was what appeared to have been a deep pit. The reporter also made a note of tuyeres found "lying loose within the cone and scattered about outside in the immediate vicinity ... 3 in. [7.5 cm] thick and having a 1 in. [2.5 cm] bore." (quoted by Brock and Brock 1963:98).

The second variant is based on a furnace inspected by G. Brock, a geologist, approximately 11 km north of Mbeya road, and 29 km northeast of Vwawa town. The variant is similar to the first one in all attributes except that the furnace had eight tuyere ports (instead of ten) near the base, seven of them varying in height between 12.5-30 cm, and the eighth measuring 45 cm high (Brock and Brock 1963).

Lastly, there is a variant described by informants, including former smelters. This employed furnaces which were very similar to the second variant, except that they had four holes at the base rather than eight. The Nyiha call such furnaces amalungu or ilungu (sing.).

Much of the Nyiha land is flat marshy plain from which smelters obtained ore for smelting. They used goethite and limonite ore (inyimbo) dug from swamps near Mbozi town. One informant described the ore as being "a fine-grained material with dark and light patches coming from a hard layer underlying the black clays of the swamps" (Brock and Brock 1963:98).

Iron smelting was conducted away from villages. The furnace was lined with short pieces of wood and charcoal up to about chest height, and the center filled with iron ore. Charcoal was added to fill the kiln to the top. Fire was lit on one side; the four holes at the bottom were closed, and the process was left to continue on its own, except that the smelters continued to charge with charcoal (ore is not mentioned). When the fire was going well, the holes were opened to increase ventilation. The larger opening was filled with pipes just like the other

three but the tuyeres were used for tapping slag out of the furnace. No flux was added, the only additive regarded as essential was the medicine based on "the meat of a snake called inyuvila and was said to be phosphorescent and water-repellent" (Brock and Brock 1963:98). One smelt continued for four days, and the bloom was taken out on the fifth through the larger hole after removing the tuyeres first.

The bloom was refined in a small furnace called ishitengwi with four openings: one large and three small that were fitted with bellows made from clay and goatskin. The initial heavy beating was done with big stones and the finishing work with iron hammers. Then the hot heated iron was plunged into water to temper and harden it. The final product included axes, hoes, spears, knives and elephant-hunting spears.

Several rituals had to be observed by the smelters. When smelting, the master and his helpers lived in the bush. They could not cut their hair nor wash until the smelting season was over. They also had to avoid sexual intercourse. Women were allowed to bring food to their men, but could not stay, as it was feared that the iron would not come out of the furnace if women slept there with their men.

Tabwa Ironworking

Across Lake Tanganyika from Ufipa in Zaire and Zambia live the Tabwa, another ethnic group that continued to practice iron smelting until the beginning of this century (Roberts 1993). The Tabwa iron technology was extensively documented by

Belgian missionaries (but most of them are in French, so could not be accessed easily by this author). However, Roberts (1993) has produced an interesting account on the subject based on his own ethnographic inquiries and accounts from previous reporters.

By the turn of the century, missionaries report to have found at least three types of furnaces in Tabwaland (Roberts 1993). The first type consisted of tall (3 or more m) furnaces with either three or four openings at the bottom to accommodate bellows and a separate, larger rake-hole that allowed withdrawal of the bloom. The second type consisted of short, one meter tall and 80 cm wide, with a single opening on one side as the rake-hole, and one opposite for the bellows. The final furnace type "appear to have been simpler still, just a hole into which charcoal and pieces of ore [were] thrown pell-mell" (Roberts 1993:7). Roberts, however, admits that he is "not clear if these were different sorts of furnaces used by people of the different ethnic groups resident in or traveling through Tabwa lands during the last decades of the 19th century, when warfare, slaving, epidemics, drought, and famine caused unusual population movement; or whether two or more furnace types were in use at the same time by the same smelters as was the case for Fipa living just across Lake Tanganyika" (Roberts 1993:7), referring to smelting and refining furnaces (<u>malungu</u> and <u>vintengwe</u>).

Smelting sites were located away from the village and close to resources, especially charcoal wood such as

Mwikalankatankata (Rhynchosia resinosa) that is also used in fertility magic. Furnaces were built by clay from termite mounds. The Tabwa mixed two ore types, magnetite which they called lulamba or malamba recorded to have 75%-80% iron, and hematite called mutapo with 60% iron. Although small deposits of magnetite sand existed throughout their country (and Roberts admits to have seen some dramatic stretches of jet-black beach along Lake Tanganyika), Tabwa iron smelters relied mainly on the compact magnetite of Mount Kalolo. High-grade hematite "could be surface-collected rather easily, and it is not clear if any was mined" (1993:5). But he also notes that "one old man told me of digging pits as deep as a house roof is high to gather the best ore".

When the smelting furnace was about to be built, the master smelter (ngezia or sisilungu) and his assistants sat cross-legged in a circle and dug the central pit together, then smoothed the "red earth" (termitary clay). To the "red earth" they added mashed leaves prepared in a mortar from Mbata or Kapatakakolwe and Mwilalankatankata trees and soil from a Kolekole mole's burrow. Then they mixed the entire concoction into the floor of the central pit, which they smoothed out again. Finally, they took a "smoke bath" of several herbs including Mulama, Mwikalankatankata, Lung'ang'ani (native basil), and aromatic Kikoti in the central pit of the furnace in preparation for furnace construction.

Oral accounts state that the smelting furnace had three openings (not four as reported by missionaries), each of which

was fitted with a bellow. Hematite ores were added first. Once the ore began to melt, the magnetite ore was added. Medicinal applications continued throughout the smelting process. Sexual intercourse was taboo for the smelters for at least four days before the smelting started. Additionally, the ngezia (master smelter) and others involved in smelting avoided contact with water and did not wash their bodies, for "water would cool [dilute] the magic of the ngezia, make the slag watery, and the ore fail to coalesce into a bloom" (Roberts 1993:5). Menstrual blood was believed to have bad power that could spoil smelting.

It is not clear whether the Tabwa bloomery process involved refining or not. Roberts confusingly notes: "My informants held that butale bloom was only smelted once, but these earlier [missionary] accounts suggest that smaller furnaces, including the 'hole in the ground' ... may have been used for second or even third smelting" (Roberts 1993:8). Nonetheless, the final product was made into various objects, including bracelets, anklets, razors, hairpins, beads, small flasks for snuff, knives, swords, arrow and spear points, bowstands, hoes, axes, awls, gouges, smithing hammers, anvils, tongs, nails, pins, bells, double gongs, keys for thumb pianos, fire-strikers, pottery scrapers, cigar-shaped ingots, and other objects.

Missionaries who had seen or used Tabwa iron spoke highly of it. For example they said that "Tabwa smelters were able to produce a soft steel comparable to that of Sweden" (Schmitz 1903, quoted by Roberts 1993:5). And when Tabwa iron was

polished, it was said to have "the gleam of silver and [rusted] less quickly than that of Europe" (Morisseau 1910:15, quoted by Roberts 1993:5).

Previous Knowledge of Ironworking Techniques Used by the Fipa

Indigenous iron production in Ufipa continued until the middle of this century (Wright 1982, 1985). The continuation of ironworking to recent times accounts for the rich ethnographic information pertaining to ironworking collected by travelers, missionaries, colonial administrators, professional ethnographers, historians, and ethnoarchaeologists (Greig 1937; Wise 1958; Wembah-Rashid 1969; Willis 1981; Wright 1982, 1985; Barndon 1992).

The Fipa oral accounts maintain that ironworking was brought by the "first" immigrants (original Fipa) who came from the southwest, led by Ntaatakwa, the founder of Milansi chiefdom ca. 1700 A.D. (Willis 1968, 1981). These immigrants settled in village communities, produced their own agricultural implements, their own axes and other tools for building, as well as weapons of war -- spears and arrows. The fact that "the present chief of Milansi is an iron smith (isiluungu), a hereditary occupation, supports the theory that the founders of the Milansi chiefdom were themselves smiths" (Willis 1968:84).

The previous researchers (Willis 1966, 1981; Wright 1982; Barndon 1992) noted only one smelting technology in

Ufipa, namely the malungu type as opposed to three recovered during the current research. Two factors contributed to this: First, the previous researchers concentrated only on the plateau where malungu are still visible on the landscape; and second, they relied mainly on oral accounts as source of information which is rich in malungu traditions given the fact that the technology is directly linked with the contemporary Fipa and some former smelters are still alive.

The previous writers report that the malungu technology employed tall, natural-draft, slag-tapping furnaces called ilungu or malungu (plural), along with a small refining furnace, kintengwe or vintengwe (plural). Ilungu measured 300-400 cm high and had a basal diameter of about 180-250 cm that tapered to approximately 120-200 cm at the top (Greig 1937; Wise 1958; Wembah-Rashid 1969; Barndon 1992).

Smelting sites were selected on the basis of their proximity to critical resources such as clay (hence close to termitaries), charcoal, ore (in the bush), and water (near streams or wells) (Greig 1937; Wise 1958; Sutton 1985; Childs 1991b; Barndon 1992). Smelting furnaces were always built on the western side of a termitary. Construction began by digging a foundation ditch measuring about the "size of [a] Fipa male hoe, ise" (about 32 cm deep and 25 cm wide), notes Barndon (1992) from her ethnographic experiments. The construction work usually took two days to accomplish and was a communal undertaking that transcended age and gender barriers. After construction, the furnace was left to dry for some days up to a

month during which time smelting accessories such as the smaller <u>kintengwe</u> furnace (measuring about 40X40 cm in height and diameter), tuyeres (used for both air drafting and slag tapping), bellows (for the refining furnaces), ore, charcoal, and firewood were prepared and brought to the smelting site. Ten slits were cut around the furnace base at even intervals and four tuyeres were placed in each.

Smelting was conducted by a team of about a dozen men led by a senior smelter. As smelting operations began, the furnace was consecrated, and therefore, only the official smelters were allowed to be at the site. Others were not permitted to come close to the smelting site (Willis 1968). The smelters were required to observe several taboos, especially sexual intercourse.

Smelting began soon after the kiln was dry. The furnace was filled with alternating layers of charcoal, ore, and wood until it was full. The kiln was then lit and left to work on its own (without bellowing) by natural draft using convection principles. Each smelt lasted anywhere between one day (as per Barndon's 1992 experiments) to three or four days reported by Greig (1937) during which time a bloom formed at the bottom of the furnace.

The bloom, however, contained significant impurities (e.g., charcoal and slag) and thus had to be refined in a smaller, forced-draft furnace (<u>kintengwe</u>) before it could be forged into tools. Refining furnaces were often placed near or in a village because they required relatively small amounts of resources

(Greig 1937; Wise 1958; Sutton 1985). The primary end product of the industry was the large Fipa hoe, ise, (Wright 1982). Other tools produced included spear-heads, arrow-heads, knives, axes, and other domestic tools.

Summary

This review chapter concentrated on three major issues. First, it discussed the history of ironworking technology at global, continental and regional (East and Central African) levels. Emphasis in this discussion was placed on the debate between the two schools of thought: external versus internal origins. Arguments from both schools were presented and it was found that neither school has enough evidence to warrant an objective conclusion. To do that more data are needed and, therefore, I call for more research on iron technology in the continent.

Second, I reviewed Iron Age research conducted in East and Central Africa and found that for a long time most Iron Age researchers were influenced by the "package" model. The presence of early ironworking, for example, was often times assumed from the presence of "related pottery" such as Urewe, Kwale, Nkope, and Mwabulambo wares. Additionally, the "related pottery" has, for a long time, been used as evidence when searching for routes of diffusion of the knowledge of ironworking. This may explain why some of the alleged routes are contradicted by the modern data. I therefore, appeal that we

reexamine the old diffusion models in the light of the new archaeological data.

Finally, I have assessed the previous research conducted in Ufipa and in the neighboring region among the Barongo, Bena, Kinga, Pangwa, Nyiha, and Tabwa with emphasis on ironworking techniques. I have observed that no archaeological survey and excavations have been conducted in these areas. The information we have from these areas is almost exclusively based on ethnographic or ethnoarchaeological sources. The absence of archaeological information has resulted in poor understanding of metallurgical and socioeconomic and culture history of these areas and other regions of East and Central Africa. In Ufipa, for example, where the current research is the first archaeological investigation, only one ironworking technology, the malungu type, was known prior to this research. The archaeological survey and excavations conducted during the current research revealed two additionally technologies, the *katukutu*, and the Barongo-type. This work will, therefore, help us to better understanding the technological, socioeconomic and culture history of Ufipa.

CHAPTER 4

THE PRESENT FIELD RESEARCH: METHODS AND STRATEGIES

The field investigations on which this study is based entailed ethnography, archaeological survey, and excavations conducted over a period of eighteen months (July 1992 to December 1993). During this time four field seasons, averaging six weeks each, were conducted. Each field season was followed by analysis of the findings at the University of Dar es Salaam. These analyses helped to keep the field research within the initial objectives since the information obtained during each analytical period was used to refine methods and techniques as well as identify areas of concentration for the next field trip.

This chapter describes and explains the various techniques employed in this field research and accounts for the use of one technique over another. Detailed descriptions of sites and materials found during the research project are provided in chapters 5, 6, and 7.

Ethnographic Inquiries

Ethnographic investigation incorporated archival studies and interviews, both formal and informal. These studies were conducted in order to: 1) collect and document information pertaining to the local history of the research area; 2) locate archaeological and historical occurrences through local informants; and 3) obtain information pertaining to iron technology, particularly that which would facilitate the interpretation of data collected from survey and excavations.

Archival studies

Archival studies were conducted at the Sumbawanga Regional Library and the Kala and Kirando missionary centers. The investigation at Sumbawanga concentrated on reports of ethnographic, ethnoarchaeological, historical, demographic, lithological, and geologic studies conducted in the region. The work at the Kirando and Kala mission centers focused on information pertaining to the history of missionaries in the area, records on iron metallurgy, and the missionaries' role vis-a-vis the growth and the decline of iron technology along the shore.

Interviews

Both formal and informal interviews were not confined to one field season, but conducted throughout the entire research period. This was done in order to ensure the reliability of the

information. It has been observed by some students of ethnographic research (Schmidt 1978a; Bernard 1988; Berger 1992) that informants often tend to be skeptical and reluctant to give complete information (let alone tell the truth) before they become comfortable with the genuineness of investigators. Interviews used throughout the research period gives local people a longer time to learn about the research and the researchers and helps to minimize skepticism. It also allows the researcher to cross check and evaluate information given in different time periods since she or he also becomes more conversant with the environment (people and their culture and the geography of the area). For the same reason, brief revisits to informants were made whenever there was a need for cross-checking information.

Informal interviews. These are distinguished from formal interviews on the basis of "the amount of control we try to exercise over the responses of informants" (Bernard 1988:204). Informal interviews are characterized by a total lack of structure or control over the informant (Bernard 1988).

We used informal interviews to obtain information pertaining to local history, traditions and customs. It was a very useful technique for dealing with sensitive informants such as women and local healers most of who were not comfortable with formal interviews. Through these informal interviews we also obtained names of potential key informants to be interviewed later. Informal informants also assisted us in locating archaeological sites. For example, the first such

interview which involved local officials (Division and Ward Secretaries) and two elders resulted in finding the first ironworking site along the lake shore, Hvlk-1. This was an important discovery because until then most local people maintained that iron technology had been practiced only on the plateau.

Formal interviews. These were structured, involved either a single informant or a team of informants and the outcomes were more controlled than those from informal interviews. Appointments were made with informants and themes of interviews were known to them at least a week in advance. The themes included traditions regarding ethnic origins, political history, local belief and customs, subsistence practices (farming, herding, and fishing), ironworking, and trade. A set of guiding questions were prepared before each interview based on the expertise of the informant. All formal interviews were tape-recorded. Additionally, photos (black/white, color prints, color slides, and polaroids) of informants and relevant ethnographic objects were taken. Extra photos were returned to the informants free of charge to reciprocate their contribution. In addition to photos, the informants were treated, according to the local customs, with dinner or local beer.

A total of twenty-six informants were formally interviewed in all four research localities (Kirando, Kala, King'ombe and Kalundi). These included six females and twenty males who varied in age from 37 to 80 years; ethnic origin

including Fipa, Lungu, Tabwa, and Ha; and occupation including farmers, hunters, fishermen, potters, local healers and priests. An annotated list of these informants is provided in appendix A.

Site Survey

Site survey was aimed at locating occurrences of archaeological materials, studying their spatial distribution, and examining archaeological land use patterns. Sites located during the survey were scrutinized for their potential contribution to the goals of the project. A few that were most suitable (as per criteria explained in the following section) were selected for more intensive investigation through excavation.

Site survey was conducted mainly during the second field season (September-November 1992). This was during the dry season when ground visibility was clear: trees and bushes had shed their leaves and the ground was bare of grass due to bush-fires (a common phenomenon in the area during the dry season).

The survey technique employed in the field involved walkovers and transects. Crew members, guided by magnetic compasses, walked along parallel transects, 10 meters apart, paying attention to site indicators such as artifact scatters and concentrations, termitaries[1], soil colorations, and vegetation

[1] After one week of survey we learned that almost all iron smelting sites were associated with termitaries.

contrasts. Shovel tests, measuring 50X50, cm were dug wherever we wanted to be certain about the presence of biological and cultural materials below ground or where we wanted to examine soil stratigraphy. River bluffs, gullies, trenches, and outcrops were closely examined for subsurface materials and stratigraphy.

Sites were recorded in notebooks, photographed, and mapped to record their general location, the distribution of cultural materials, and the location of important features and landmarks including anthills, rivers, and large trees. Ubiquitous materials, such as pottery, slag, and tuyeres, as well as immobile objects such as furnaces, were measured and left in their respective sites. Tuyeres were recorded for length, diameter, and thickness, body part (base, center, or tip), body condition, paste, temper and weight. Furnaces were measured for their approximate height, diameter, wall thickness, colors on the exterior and interior, surface condition (interior and exterior), and distance and direction in relation to associated termitaries. Only important and diagnostic artifacts, such as old and decorated potsherds, slag (there was very little slag found on sites along the lake shore), and tuyeres (especially the longest, widest, or narrowest pieces), were collected for further analysis at the camp or in the archaeology laboratory at the University of Dar es Salaam. Archaeological features, such as ore and clay quarries, wells, termitaries, historical monuments, grindstones, as well as mounds or heaps of

artifacts, that included slag and tuyeres, were measured, recorded and photographed in situ.

The site survey covered a total area of 97 km^2: 84 km^2 at Kirando, 3 km^2 at Kala, 4 km^2 at King'ombe, and 6 km^2 at Kalundi. The sampling strategies employed in selecting these survey areas are discussed in the locality descriptions below. The investigated area (97 km^2) yielded seventy-five sites, ranging in cultural contents from the Later Stone Age microlithic artifacts and Early Iron Age pottery (Kalambo tradition) to ironworking (smelting and refining), ore sources, cave camps, ritual grounds, and historical monument (Fig. 4.1). The sites were enumerated according to the Standardized Site Enumeration System for the Continent of Africa (SASES) (Nelson 1971) beginning with a code number: Hvlk for Kirando, Iall for Kala, Ialm for King'ombe, and Hxlo for Kalundi (for a SASES map of Tanzania see appendix B). The code number was followed with a serial number assigned in the order in which the sites were found.

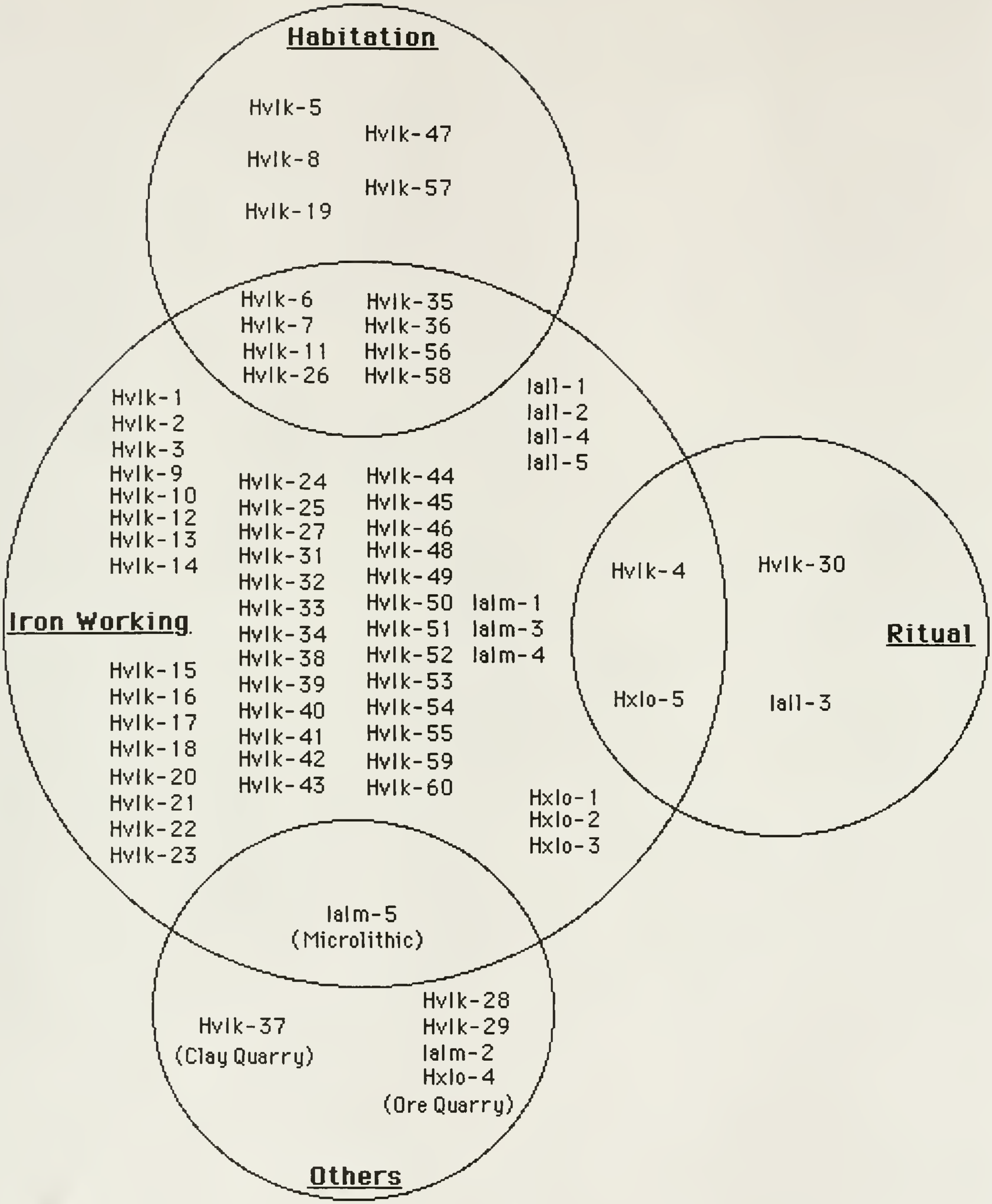

Fig. 4.1 Venn Diagram of Site Types

The following are specific descriptions of each research locality.

Kirando, SASES Grid Hvlk

The site survey at the Kirando locality was confined to along the shore in an area defined by the following geomorphological boundaries: Lake Tanganyika to the west, the Chabya and Mosi-wa-Mpepo hills to the east, the Chongo and Wangubo hills to the north, and the Nkanga hills to the south (Fig. 2.1). This area measured roughly 12 X 13 km east-west and north-south and included seven islands, the largest of which measured 2.5 km^2. It encompassed five eco-zones: islands, shore plains, seasonal swamps, lacustrine marshes, and hills (Fig. 2.1).

Before I visited the area, I had planned to sample a 0.5x0.5 km area from each ecozone (that is, one island, one hill, and a coast-to-inland transect of 0.1x13 km) that would be thoroughly surveyed in order to determine the archaeological potential of each zone. Results from this preliminary survey would be used to construct a stratified sampling strategy for a total of 75 km^2, almost fifty percent of the Kirando area. But this strategy was changed after visiting the area and learning that about 45% of Kirando area was inaccessible, and therefore could not be surveyed. This included the lacustrine marshes (inhabited by hippos and crocodiles), a small part (4%) of the seasonal swamps having a dense overgrowth of riparian reeds, and precipitous mountains.

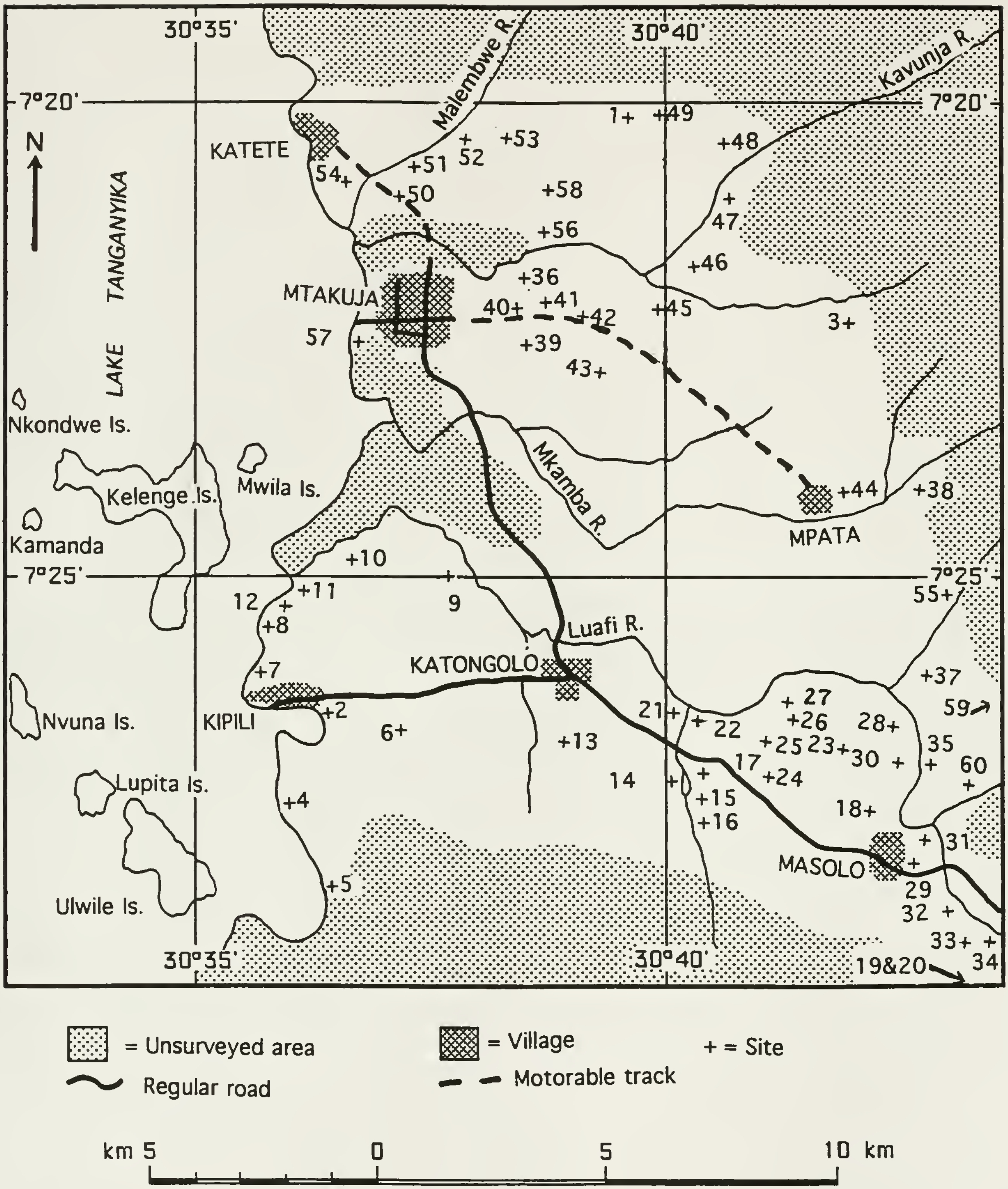

Fig. 4.2 Site Locations at Kirando

The whole of the remaining area (55% of the total area) was surveyed. This amounted to 84 square kilometers in which sixty sites were located (Fig. 4.2). Fifty-two of the sixty sites had evidence of iron-working, such as furnaces, slag, tuyeres, iron ore, and charcoal. Thirteen habitation (residential) sites were found, marked with potsherds and/or daub (seven sites had both iron-working and habitation evidence). The remaining sites were ore sources (2), ritual areas (2), cave shelter (1), and source of potting clay (1) (Fig. 4.1; for detailed information see chapter 5).

Kala, SASES Grid lall

Kala is a small village situated in a natural harbor that is protected by two islands, Mikongolo and Kala--the source of the village name.

The locality consisted of three eco-zones: the islands, the Mwiu river plain, and the mountain escarpment (Fig. 2.2). All three zones were surveyed using the same technique as described before (walk-overs along parallel transects and shovel tests). The river plain, the largest zone of the three eco-zones, was largely covered with cassava farms. Each farm was bounded by trenches dug by the farmers to protect their crops from wild pigs. Since the top soil was highly disturbed by cultivation, it was imperative to closely examine the trenches for cultural materials. All revealed only natural stratigraphy including fine white sand at the top (30 cm), underlain by a layer of coarse sand mixed with red gravels.

The area surveyed amounted to three square kilometers and yielded five sites: three at the base of the escarpment, one on the river plain, and one on Kala island (Fig. 4.3). Four sites (Iall-1, 2, 4, and 5) had evidence for ironworking and one (Iall-3) was a ritual site (Fig. 4.1; for detailed information see chapter 5).

King'ombe, SASES Grid Ialm

King'ombe is a terrace on the Fipa escarpment about ten kilometers east of Kala. It is generally flat and surrounded by small perennial streams: the Kausizwe to the east, the Kalosi to the north, and the Msakamanga to the west (Fig. 2.2).

The survey covered four square kilometers in which five sites were found (Fig. 4.3). Four sites (Ialm-1, -3, -4, and -5) had evidence for ironworking and one site (Ialm-2) was an ore source. Site Ialm-5 also yielded "Later Stone Age" materials, dominated by micro-scrapers and burins (Fig. 4.1). Three 50x50 cm test pits were dug at this site (Ialm-5) to determine the stratigraphic context of the cultural materials. We found that the subsurface consisted only of stone tools, no ironworking materials were found. This is not surprising because the ironworking materials, consisting of three refining furnaces and slag piles belonging to the *malungu* technology, seemed to be recent, most probably dating to the 19th century (for detailed information see chapter 5).

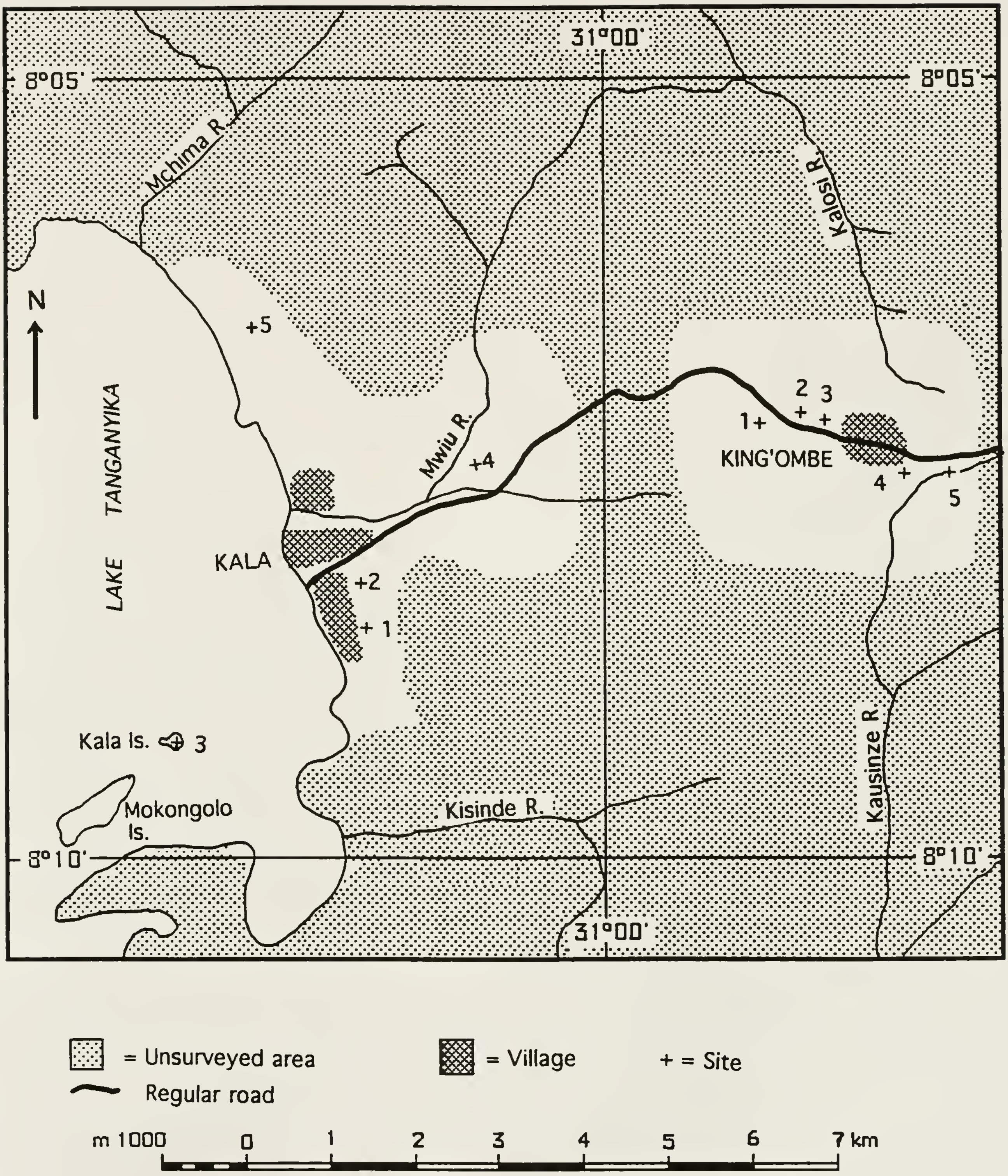

Fig. 4.3 Site Locations at Kala and King'ombe

Kalundi, SASES Grid Hxlo

The village of Kalundi is located on the Fipa plateau about 40 km northwest of Sumbawanga, along the southern Sumbawanga-Namanyere road (Fig. 1.2). It is situated on a highland bordered by two basins, one to the east and another to the west, and is bound to the north by a granitic dyke, called Tapepo ridge (Fig 2.4).

This study revealed that Kalundi had been one of the most important iron ore sources on the plateau and that a magnificent iron industry had flourished there during the Later Iron Age. Smelting and refining sites had been conveniently located on a highland, west of the village, between the western basin and the Chumasilu river and Tapepo ridge (Fig. 2.4). This was close to the source of bog ore in the western basin and a stand of mibula (*Parinari curatellifolia*) trees which provided wood and charcoal. This area was also close to water sources (the Chumasilu river and the basin), and away from the village (providing the privacy needed by Fipa smelters).

About six square kilometers were surveyed at Kalundi, yielding five sites (Fig. 4.4): four ironworking (three iron-smelting and one iron-refining), and one ore source. One iron site was also used for ritual purposes (healing) (Fig. 4.1; for detailed information see chapter 5).

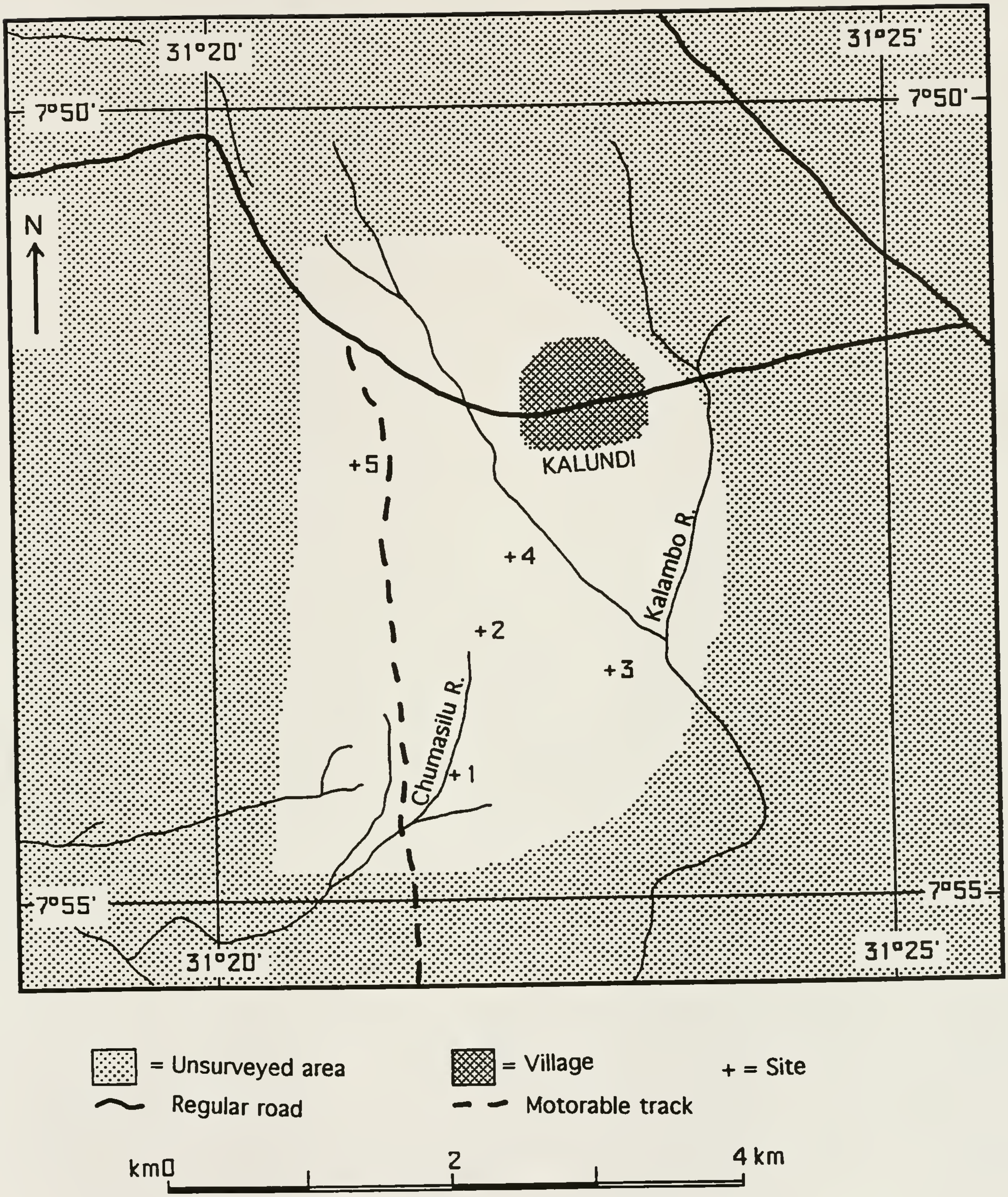

Fig. 4.4 Site Locations at Kalundi

Smelt frequency formula. At the end of the survey we devised a formula to estimate the number of smelts performed at a furnace before it was abandoned. The formula was based on the amount of tuyeres found at each site or smelting locale of the malungu type of technology and was formulated according to the following syllogisms.

We knew that each lilungu (sing. for malungu furnaces) had 10 tuyere ports (including a wider opening, = palinyina) and that each ordinary port was packed with 3 or 4 tuyeres and the palinyina had twice that number. That is to say furnaces which used sets of three tuyeres employed 33 tuyeres in total per smelt and those that used sets of four tuyeres per port needed 44 tuyeres per smelt. It was therefore possible to estimate the number of smelts the furnace endured before it was abandoned by determining the amount of tuyeres contained in a refuse pile of the furnace. This could be done by dividing the total number of tuyeres by either 33 (for the triple-tuyere bundles) or 44 (for the quadruple-tuyere bundles).

Given the large volume of the furnace refuses we were not able to examine every single tuyere. Instead we sampled three furnaces, one from each of the three geographical regions. These included sites Hvlk-39 along the shore, Ialm-4 on the escarpment and Hxlo-2 on the plateau. The first two each had a small heap (0.15 and 0.5 cubic meters respectively) and the last had a medium size heap (2 cubic meters). At each furnace we conducted actual counts and weight measurements. The number

varied from 234 to 408 complete[2] tuyeres per cubic meter of smelting refuse and each tuyere had an average weight of 0.8 kg (computation based only on tuyeres that were free from slag coating and clogging). The number of tuyeres per site was then estimated by multiplying the volume of smelting refuse by 321 (average number of tuyeres per cubic meter of smelting refuse). The product was then divided by either 44 or 33 to get the approximate frequency of smelts per furnace.

The formula can be shortened as:

$$\frac{T}{S} = F$$

Where:
T= number of tuyeres per single-furnace site.
S= number of tuyeres used per smelt per furnace.
F= minimum frequency of smelts per furnace.

Findings based on this formula are used in chapter 5 to explain properties of the malungu ironworking technology.

Two points, however, are worth noting in regards to the margin of error for this formula. First, this formula gives only a minimum number of frequency because it does not take into account the number of tuyeres that were reused as supporters removed from the site after its abandonment. Second, this formula cannot work (or at least is not recommended) in technologies that recycled tuyeres for air conduction or where one pile of refuse was shared by more than one furnace. In such cases the margin of error would be very high. For this reason

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2 A complete tuyere averaged 26 cm in length. Thus, length measurements of tuyere pieces were added up and divided by 26 to get the approximate number of complete tuyeres.

we did not use it to compute smelt frequencies in the katukutu technology.

Excavations

The third and the fourth field seasons (October-December 1992 and September November 1993) were devoted to excavations conducted in order to: 1) identify the stratigraphic positions and thus the relative chronology of the cultural materials found on the surface during site survey; 2) find more archaeological artifacts and features (furnaces, tuyeres, slag, potsherds, daub, and stone artifacts) to assist in reconstructing the social and technological history of the area; and, 3) obtain datable materials, especially charcoal, needed to construct an adequate culture history of the area.

Iron metallurgy and settlement were given more emphasis when selecting sites for excavation. This was because these two variables were the primary subjects of the research. Geographical locality was also considered in selecting sites, because we wanted to understand the spatial variability of the cultural materials. Thirteen sites (17%) out of the 75 sites found during the research project were excavated. Ten of these, including Hvlk-1, 11, 17, 19, 25, 26, 32, 35, 39, and 58 were from Kirando (Fig. 4.2); two, Ialm-1 and Ialm-4, were located in King'ombe (Fig. 4.3); and one, Hxlo-2, was situated in Kalundi (Fig 4.4). Five sites (Hvlk 11, Hvlk-35, Hvlk-57, Ialm-5, and

Hxlo-4) were tested by the shovel-test method. Details of the findings are provided in chapter 6.

The locations of excavation units were determined by a variety of indicators, including artifacts protruding at the surface, variations in soil coloration, and topography (mounds or depressions). In the absence of natural indicators, a metal detector and/or auger and shovel tests were used to locate places with high concentrations of cultural materials in the ground. A contour map was made for every site that was excavated. Datum points for each site were usually located adjacent to relatively permanent landmarks, such as large trees, rock boulders, or termite mounds to facilitate relocation in the future. Each datum point was temporarily marked with a wooden stake with a six-inch iron nail placed at the center. We anticipated to replace the stakes with concrete blocks, but this was not done because of limited time.

Excavation was principally done with trowels. A few pits with extremely hard soil and low density of cultural materials were dug with a hoe. In most cases arbitrary levels of 5, 10, 15, or 20 cm, rather than natural layers, were followed since natural layers were often nonexistent, too thick (over 30 cm), or too complicated. Excavation units varied in area and depth depending on the specific objective of a given excavation, as well as the depth of the cultural materials. The largest unit in the project measured 300X300 cm while the smallest measured 150X50 cm. Important observations regarding excavation (e.g., placement of materials in the excavation units) were recorded

in notebooks, photographs (black/white, color print, color slide and polaroids), and drawings of wall profiles and floor plans. Excavated soil was screened through a 5-mm wire mesh in order to control the chance of overlooking small objects such as animal teeth, bones, and beads.

Cataloguing and Quantitative Analyses

Samples collected from both survey and excavation were kept in plastic bags and taken to the camp for cleaning and cataloguing. Metal objects, metallic slag, charcoal, and highly weathered bones and potsherds were not washed in water but were left to dry and later brushed or the dirt was picked off using tooth picks. Charcoal samples selected for carbon dating were cleaned, wrapped in aluminum foil, and kept in plastic bags.

Basic quantitative analysis of the materials, including cataloguing, counting, weighing, and size measuring was conducted mostly in the field (both at the sites and at the research camp). Ubiquitous materials, such as tuyeres, slag, potsherds, and furnace rubble (especially when found on the surface) and immobile features such as furnaces, were recorded at their respective sites and were left. After recording, a few samples were collected for detailed analysis. These were brought to the camp where they were washed, catalogued, and analyzed.

Detailed attribute analysis of pottery, tuyeres, and slag as well as the comparative analysis of the findings in time and space with materials from other sites in East and Central Africa, were conducted at the University of Dar es Salaam during the periods between field trips. Species identification of faunal and floral materials was mostly conducted in the field with some help from local experts, including hunters, traditional healers, charcoal burners and fishermen. Some faunal, as well as geological, materials were identified by specialists from the Zoology and Geology Departments, University of Dar es Salaam.

Exhibition and Research Assessment

I have argued elsewhere (Mapunda n.d.) against the tendency found among some archaeological researchers to ignore the importance of sharing knowledge gained in field research with local people. Some researchers involve local people only as sources of physical labor and information. Villagers who are the caretakers and the direct heirs of the cultural heritage retrieved from their communities are often times neither informed about the relevance of archaeological research nor shown the findings so that they can appreciate their value. These researchers forget that it is through such knowledge that local people can become aware of both the scientific significance of archaeological materials and the

cultural link existing between themselves and the findings. Recognition of this connection creates some cultural awareness and sense of pride among local people, crucial qualities for conserving archaeological materials. Furthermore, educating local people about their cultural heritage can significantly minimize the problem of site destruction and looting evident in many places in Africa and elsewhere in the world.

With this mission in mind we organized an open exhibition at Kirando at the end of the research period. Our objective was to expose the general public to the findings and to share with them the knowledge we acquired through the project. We also wanted to get their opinions regarding the research project, particularly about how the project could have been better organized and how archaeological knowledge could have been disseminated more effectively to them. Such information would aid us and other researchers in planning similar research projects in the future.

The project assessment was conducted on a Sunday and was open to the public. Some people were given formal invitations, such as local village leaders, formal interviewees, some people who had played a significant role in the research, and those who had been curious or strongly interested in what we were doing.

The event began with a lecture on the meaning and relevance of archaeology to day-to-day lives and how the research was related to understanding the culture history of Kirando, Ufipa, and other regions of the world. Then samples of

materials from our collection including stone tools, tuyeres, slag, furnace wall, pieces of iron ore, bones, and charcoal were displayed and people were allowed to view and ask questions. We concluded the event with a discussion session which dealt with questions and answers involving both the research team and local people. The discussion focused on, among other issues, species identification of faunal and floral materials collected in the region.

The understanding we got through this seminar was very constructive. It provided some insights towards local appreciation and preservation of cultural heritage. People were highly impressed with the idea of incorporating them in the research, educating them about history and archaeology, and sharing with them the knowledge we had acquired through the research project. They confessed that the seminar helped them understand their own history better than before especially in regards to iron technology. More importantly, they learned that there had been people living along the shore before them and that these people were ironworkers who used a different technology from that used by the immediate ancestors of the contemporary Fipa. This was important because they had thought that large scale iron production had been practiced only on the Fipa plateau. They realized that the basic factor which had prevented them from recognizing relics of ironworking from their premises was that they had been stereotyped by the tall, natural-draft furnaces (malungu) of the plateau. It was thus difficult for them to realize that the dwarf (katukutu) furnaces,

most of which were highly disintegrated, were relics of ironworking.

Laboratory Analyses

Phase[3] and elemental analyses of iron objects and slag were conducted at the University of Florida. These analyses focused on technological problems which could not be solved from the attribute analyses of the findings explained above. The problems are explained in length in chapter 7 and include determining whether the katukutu technology was ferrous or non-ferrous, and bloomery or blast, as well as establishing the smithing techniques used to fabricate the metal objects retrieved during this research project.

Sampling

Table 4.1 presents the total numbers and weights of samples of slag, iron ore (partially reduced [PRO] and unreduced [URO]), blooms (blm) and metal artifacts (mtl) collected in the field for attribute, metallographic and elemental analyses.

3 A phase is "a material having the same composition, structure, and properties everywhere under equilibrium conditions". (Askeland 1989: 274).

Table 4.1 Some materials collected for intensive analyses (attribute, metallographic and chemical)

	Slag[4]						Blm	Ore		Mtl
	Am	An	Bm	Bn	Cm	Cn		PRO	URO	
#	1723	1409	744	1006	613	243	102	51	40	3
wgt	21777	9409	7335	10320	6797	2547	1107	426	1173	645

Fifty-four samples were analyzed: 41 by metallography to identify phases; 2 by Energy Dispersal Spectroscopy for elemental analysis; and 11 for both phase and elemental identification. The samples included 33 pieces of slag, six pieces of bloom, six pieces of partially reduced iron ore, two pieces of unreduced ore, a piece of vitrified furnace wall, and three metal artifacts. Twenty-three samples represent the katukutu technology, twenty represent the malungu technology, and eight represent the Barongo-type technology. The remaining three were iron artifacts and were treated as separate category. Detailed information of the materials, including provenances, phases, and elements are provided in appendix C.

Sample selection was based on factors such as: the type of problem intended to be solved; representativeness in terms of geographical locality, technology, and typology; number of

[4] Smelting and refining slag found in this work is divided into three major types (adopted, with some modifications, from Killick 1990): A, B, and C. Type A includes tap slag which often cools and solidifies outside the furnace. It usually appears as flat "cakes" or fingers with conspicuous flow marks on the surface. Type B slag is blocky or blob-shaped, often rough on the surface, marked with charcoal impressions or impregnated with charcoal. It solidifies at the bottom of the furnace. Type C slag consists of drippings from furnace wall or tuyeres. The pieces are either spherical or cone shaped--the narrow end is rounded and smooth, whereas the wider end (base) is rough and may contain unreacted clay. Most pieces appear in mottled colors. The subtypes (m and n) are based on iron content: m = metallic and n = non-metallic. For more information see chapter 5.

samples available; and, financial capability. For example, although only three samples were analyzed in order to reconstruct smithing techniques, this was 100% of the iron artifacts found during the entire research project. On the other hand, although many samples could be used to determine the chemistry of the iron ore, slag, and blooms, only thirteen pieces were analyzed because of limited funds. These thirteen samples, however, represented all material types, technologies, and geographical localities as shown in appendix C.

Sample Preparation

Micrographic examination of objects requires that "a section [of the object] be cut, that the surface of the section be prepared to a high-reflection condition, and usually that this surface be etched suitable to develop that structure of interest" (Samuel 1980:3). This study involved all these steps plus photographing interesting areas of each section.

Sectioning. Most samples were small enough (less than 20 mm in diameter--the mold was 25 mm wide) to be mounted without cutting. Large pieces of slag were chipped off manually by lightly hammering a screw-driver into cracks. This technique was preferred to using an electrical saw which might affect the grain structure due to the high temperature produced during cutting. Metal objects and blooms were cut using a hand saw (No. 0.2 blade) and a slow-speed lubricated Precision Diamond saw.

Mounting. All sections were hot-mounted using bakelite powder heated under pressure to a maximum temperature of 140 °C.

Grinding. All samples were ground over the following grits: 120, 240, 320, 400, and 600 lubricated with water. The samples were then fine-polished over 6- and 1-micron diamond paste. While the 1-micron diamond paste was fine enough for the slag samples, the blooms and iron artifacts were also polished over 0.5 micron alumina precipitate since they are soft compared with slag.

Etching. A few samples rich in iron (bloom and iron artifacts) were etched with 2% nital (nitric acid (2 ml) and ethyl alcohol (100 ml)) for the purpose of exposing the structures contained in metallic iron. Two percent nital helps to reveal the different phases of metallic iron: it etches the grain boundaries of ferrite, and reveals cementite mainly by developing relief between cementite and the surrounding ferrite (Samuel 1980).

Analyses

The results of metallographic and elemental analyses are presented in appendix C, while discussions of the problems focused on during these analyses are provided in chapter 7.

CHAPTER 5

EVIDENCE FROM ETHNOGRAPHY AND SITE SURVEY

We noted in chapter 4 that surface investigations by site survey and ethnographic inquiries for the occurrence of archaeological materials yielded 75 sites: 60 around Kirando and 5 from each of the remaining research localities (Kala, King'ombe and Kalundi). This chapter presents a cultural (functional) typology of these sites. This is aimed at exposing the cultural variability and hence, the archaeological potential of southwestern Tanzania.

Six functional site groups were identified. These included ironworking, quarries of iron ore, habitation, ritual locations, microlithic industrial areas and quarries of potting clay. The function of each site was determined by the amount and context of the cultural materials found on the site. Emphasis was given to a primary as opposed to a secondary context. For example, when only few, say less than five pieces of slag were found in a site with concentrations of daub, potsherds, and animal bones, the slag was assumed to be in secondary position. The site, therefore, would not warrant the label "dual-functional" (ironworking and habitation), but rather mono-functional, namely habitation site. But when more than five pieces of slag

were found (especially together with tuyere fragments) in such a context the site was regarded as dual-functional (see examples in Fig. 4.1).

Ironworking Sites

Figure 4.1 shows that 66 out of the 75 sites found during this research project had evidence for ironworking (smelting and refining). The evidence used to determine this category of sites included furnaces, tuyeres, slag, pieces of iron ore, blooms, charcoal/ash, and termitaries. An area was called an ironworking site when two or more different types of these materials were found together. It should be noted that bellows which are also good evidence for ironworking were not recovered from the archaeological record. This is because their use was limited to refining and Barongo-type furnaces (described below) both of which accounted for only 14% (9 sites) of all ironworking sites recovered. The remaining furnaces were operated by a convection process. The refining process employed portable, wooden bellows (that have a poor preservation quality) that were kept at home rather than at a production site.

The ironworking evidence point to three distinctive ironworking technologies in Nkansi District and Ufipa in general. These include the malungu, katukutu and Barongo-type. These three technological types differ in techniques, material

attributes, chronology and spatial distribution. This chapter discusses variables that are observable from the ground surface. Variables recovered after excavation and those recognized through microscopic analyses are presented in chapters 6 and 7, respectively.

Katukutu Technology

Before going into detail about this technological type it must be pointed out that it was poorly known by local people. With the exception of a few hunters and honey collectors who had seen some katukutu sites in the wilderness most of the local people were as ignorant and as curious as we were about this technology. For this reason, many queries we had in regards to the technological, historical, and socio-cultural aspects of this technology could not be solved by informants.

Of the sixty-six sites with evidence for ironworking fifty-one belonged to the katukutu technology (Table 5.1). These included Hvlk-1, -2, -3, -4, -6, -7, -9, -10, -11, -12, -13, -14, -15, -16, -17, -18, -20, -21, -22, -23, -24, -25, -26, -27, -31, -32, -33, -34, -38, -39, -40, -41, -42, -43, -44, -45, -46, -48, -49, -50, -51, -52, -53, -54, -55, -56, -58 and -59 from Kirando (Fig. 4.2); Iall-4 from Kala (Fig. 4.3); and Ialm-1 and Ialm-3 from King'ombe (Fig. 4.3).

Table 5.1: Distribution of Ironworking Sites by Geographical Regions and Types

Locality	MALUNGU	KATUKUTU	"BARONGO"
Kirando (shore)	1	48	3
Kala (shore)	3	1	
King'ombe (escarpment)	4	2	
Kalundi (plateau)	4		
Total	12	51	3

Table 5.2: Geographical Distribution of Ironworking Furnace Types

LOCALITY	MALUNGU		KATU-KUTU	BARONGO	TOTAL
	Smelting Furnaces	Refining Furnaces	Smelting Furnaces	Smelting Furnaces	
Kirando	1		186	3	190
Kala	1	5	2		8
King'ombe	12	26	30		68
Kalundi	18	3			21
Total	32	34	218	3	287

The surface observation revealed the following characteristics of the katukutu technology:

Furnaces. The site survey yielded around 218 katukutu furnaces (Table 5.2). Six of these were complete, 188 had fallen, and about 22 had been dismantled through cultivation and the number had to be estimated based on a reconstruction from the furnace rubble. The distribution of furnaces per site varied from one to fourteen with five being the mode. The density varied from 105-306 m^2 per furnace, averaging 48.6 furnaces per hectare. All furnaces had been buried following the abandonment of the sites such that the tuyere ports could not be

seen on the surface (Fig. 5.1). This prevented us from taking height and diameter measurements of furnaces, as well as count the number of tuyere ports and take their dimensions, during survey (for these and other measurements see chapter 6).

Fig. 5.1 Katukutu furnace (F1) from site Hvlk-1 as seen on the surface.

About 25% of the furnaces consisted of more than one layers (2 or 3) of wall. The outer layer(s) were reinforcements added after the inner (primary) layer either cracked or became thinner from melting and vitrification. This indicates that the furnaces were re-used. The exterior surface was either rough, smooth, or decorated. Decoration was consistent in element, motif, and technique but varied in its location on the furnace body, its orderliness of application, and the types of tool used. The decorative element consisted of holes punched using a stick

or a finger (as revealed by the impressions left on the edges of the holes). This was either applied on the entire body or only above the shoulder (Fig. 5.2). The holes varied in depth from 0.5 to 2.5 cm and were spaced between 0.8 and 12 cm. Although variations in the depth and spacing of the holes, as well as the type of tool used, were more pronounced between sites, differences within sites and even within furnaces were not unusual.

Fig. 5.2 Decorated katukutu furnace (F10), site Hvlk-25

This decoration motif was unique to furnaces; we did not find it in pottery and local people did not know what the motif meant. Furnace interiors were highly vitrified or melted (Fig. 5.3). The smelters may have deliberately used clay of poor

refractory quality in order to flux the iron-rich magnetite ore used (see more discussion in chapter 8).

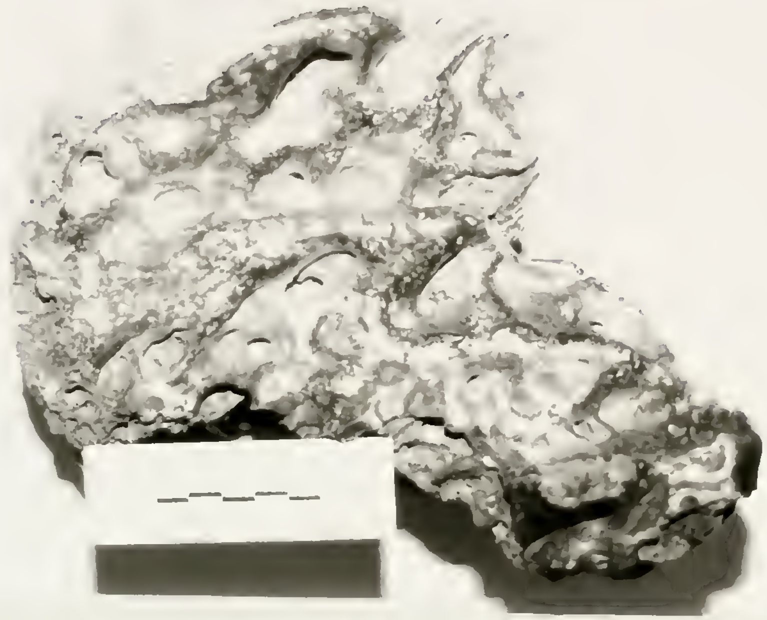

Fig. 5.3 Piece of furnace wall showing vitrified interior, site Hvlk-17

Tuyere ports. Of all 194 complete and fallen katukutu furnaces only one (at site Hvlk-48) had tuyere ports visible on the ground. And even there only one half of the furnace (the up-hill side) revealed ports, while the other half was buried. This discovery was celebrated because it helped solve an implied paradox that the furnaces operated with tuyeres but without tuyere ports (Fig. 5.1 and 5.2). Although this discovery helped us to learn that the furnaces had tuyere ports it could not explain why the ports were "underground". This was learned through excavation (see chapter 6).

Tuyeres. These were the most abundant materials in katukutu technology (Fig. 5.4). One to three piles, averaging 2 m in basal diameter and 1 m in height were found at all except three sites: Hvlk-21, 22, and 31. Disturbed sites (those located in fields) also had tuyere piles, but were secondary contexts made by farmers when clearing land for cultivation (Fig. 5.5).

Fig. 5.4 A pile of tuyeres in a primary context, site Hvlk-20, Kirando.

Fig. 5.5 A pile of tuyere and furnace rubble in a secondary context, site Hvlk-53, Kirando.

The unusual paucity of tuyeres observed at the three sites (Hvlk-21, 22, and 31) mentioned above seemed to have resulted from a relatively short period of use before they were abandoned. This was suggested by the presence of a low number of furnaces at these sites (a single furnace each at Hvlk-21 and 22 and two at Hvlk-31). It is also possible that the meagre amounts of tuyeres left after the brief operation may have been collected either by the same smelters and reused in other sites or by subsequent inhabitants. We noted, for example, that contemporary iron-smiths reuse tuyeres from old smelting sites in their forges (connecting them to bellows). They believe that the old tuyeres contain some special magic powers that could bring some fortune.

Tuyeres were small in size, varying in external diameter from 3.3 to 6.0 cm and in internal diameter from 1.6 to 4.0 cm. The external diameters revealed two modes, one at 4.0 cm and the second at 4.4 cm. Although the higher mode (4.4 cm) generally correlated with decorated furnaces, the two variables (furnace decoration and binary modes for tuyere diameter) seem to be stylistic rather than technological characteristics. This is because the binary mode was conspicuous only on the external diameters and not internal diameters. The latter is technologically more important because it affects the volume of air which flows into the furnace which, in turn, affects combustion (temperature) and the chemistry of iron and slag. Additionally, the plain and the decorated furnaces were similar in all other variables (see "furnaces" in chapter 6).

Tuyeres were not flared, they were uniform in diameter from tip to tip. Some tuyeres were found in bundles of triples cemented together with slag, suggesting that each tuyere port housed three tuyeres. Both the absence of flared ends (usually providing a receptacle for bellows) and the application of multiple tuyeres in a port suggests that bellows were not used in this technology. This implies that natural draft rather than forced draft was used in this technology.

Sometimes tuyeres were cut into short (10-20 cm) pieces and piled horizontally inside the furnace below the tuyere ports to support the parts of tuyeres that projected inside the furnace. Tuyere supporters were distinguished from the actual blow pipes by their short length, rough slag coating over the

whole body, slag blocking their interior, and bundles which consist of crisscrossing layers of tuyere pieces. Tuyere tips were highly vitrified. Slag clogging or slag coating inside the tuyeres was nonexistent. This indicated that they were placed at a downward sloping angle towards the interior of the furnace (also confirmed by excavation, see chapter 6).

Only four complete tuyeres were recovered during survey: three on the surface (from survey) and one from excavation (Fig. 5.6). Dimensions and weights of these tuyeres are presented in table 5.3. The surface finds came from site Hvlk-20, the furthest site from contemporary settlement (10 km SE of Masolo (Fig. 4.2)) and the excavated one from site Hvlk-25.

Fig. 5.6 Complete tuyeres from the katukutu technology

Table 5.3 Measurements of complete tuyeres

Serial #	Site	Length (cm)	External Diameter	Internal Diameter	Weight (gm)
1	Hvlk-20	40.0	3.5	2.3	395
2	Hvlk-20	41.2	4.1	2.3	749
3	Hvlk-20	44.0	3.9	2.2	523
4	Hvlk-25	50.0	4.0	2.3	780
Average		43.8	3.9	2.3	611.8

Both ends of tuyeres # 1, 2 and 3 were vitrified suggesting that each tip had sometime been inside the furnace. This suggests that the katukutu smelters reused their tuyeres. This made it difficult to know what portion of these tuyeres protruded inside the furnace based on indicators such as oxidation, vitrification, and slag coating. Tuyere #4 revealed three separate zones of thermal effect: vitrification at the tip a fragment of another tuyere cemented to it; followed by a reduced zone (dark gray); and finally an oxidized zone (orange-red) with no slag. The border between the second and last zones was conspicuously abrupt suggesting that the last zone was bound by the furnace wall. The observation from this tuyere showed that between 25 and 30 cm of the tuyeres projected inside the furnace interior. This was further supported by in situ tuyeres revealed during excavation at site Ialm-1 discussed in chapter 6.

Slag: Before discussing about slag found at katukutu sites per se it is important to understand the general classification of slag found in the entire research project. Smelting and refining slag found in this work was divided into three major

types (adopted, with some modifications, from Killick 1990): A, B, and C. The divisions were based on physical properties (observable in the field), including morphology, size, color, fragility, macro-inclusions and where the slag solidified (whether inside or outside of the furnace). Each of the three types was further divided into two sub-types ("m" and "n") based on iron metallic content determined by magnetism, density and color on the surface.

Type A included tap slag, that is slag that solidified outside the furnace, as well as slag that solidified inside tuyeres (causing tuyere clogging). Type A slag usually consisted of flat "cakes" or "fingers" with conspicuous flow marks on the surface. Slag which solidified inside the tuyeres was cylindrical, following the shape of the bore thus, it is also referred to as tuyere-molded slag in this work. Magnetism was relatively low in Type A slag.

Type B slag solidified at the bottom of the furnace. It consisted of blocky or blob-shaped pieces, often rough on the surface, marked with charcoal impressions or impregnated with charcoal. Generally, this slag type was highly magnetic (sub-type B-m).

Type C slag consisted of pumice-like pieces (mostly sub-type C-m), as well as drippings from furnace wall or tuyeres and solidified inside furnaces. The pumice slag was amorphous, whereas drippings consisted of dendritic forms, single pieces or balls. Each single branch of the dendrites or the single pieces were cone shaped--the narrow end was rounded and smooth,

whereas the wider end (base) was rough and sometimes contained unreacted clay. Most of sub-type C-n (non-metallic) were mottled in a variety of colors including blue, red, brown, coppery, red, and white. Having seen these general types let us now turn to katukutu technology.

Katukutu technology was peculiarly poor in slag. The most common material resembling slag were vitrified clay: tuyeres, furnace walls, and gangue (ore matrix). The dark, denser slag existed largely as droplets and acicular pieces. The largest piece of slag recovered during the survey was a massive and metallic piece (Type B-m) measuring 1.4 cm in diameter and weighing 6 grams. Several factors seem to have contributed to slag paucity in the katukutu technology, including slag reuse, corrosion, and the nature of the technology itself (see chapter 7 for details).

Iron ore. Surface investigation on the katukutu sites revealed only eleven pieces of iron ore, weighing 0.145 kg. Qualitative analysis conducted at the Department of Geology, University of Dar es Salaam, revealed that these pieces were iron-rich magnetite (Fe_3O_4) ore.

Site size and location. Katukutu sites ranged in size from 40-2500 square meters (except site Ialm-1 which also had malungu furnaces, measured 20,000 m^2). The sites were located within a distance of 300 m from water sources such as wells, boreholes, swamps, rivers and Lake Tanganyika. Furnaces were always located around or near termitaries. This allowed easy access to clay for furnace and tuyere constructions. This

is suggested by similarity in texture and composition between the termitaries and furnaces and tuyeres at each site, as well as the presence of borrow pits (seen only in some 10% of the sites because of termite rebuilding).

At one site (Hvlk-25), however, there was no termite mound found within the site and the furnaces were randomly scattered, instead of being placed in a circular pattern as was often the case. The nearest termitary was located 30 meters from a furnace. It is very unlikely that this was the source of clay for the fourteen furnaces found at the site, because it is relatively far away and young. The termitary which provided clay for these furnaces had probably been located within the site but was exhausted through time.

There was no preference for direction in building the furnaces (as was the case with the <u>malungu</u> technology discussed below). Smelting sites were located outside villages. This was indicated by the absence of non-technological materials such as daub, potsherds and bones around the sites, as well as the ubiquity and the wide distribution of the sites.

<u>Spatial distribution.</u> Based on the site survey, the <u>katukutu</u> technology was located strictly near Lake Tanganyika: along the shore and on the escarpment. Local informants (hunters and honey collectors) reported the occurrence of <u>katukutu</u> furnaces as far north as the Rivers Ifume and Manda around Karema and as far south as northern Zambia. The informants also agreed that the furnaces were located within 20 km of Lake Tanganyika.

Relative chronology. When we asked local people about the history of the katukutu technology and the people responsible for it we got a variety of answers. Although all agreed that katukutu sites had been there long before their fathers came to the shore (from the Fipa plateau, Zambia and Zaire), they disagreed on who the smelters were. They attributed the katukutu technology to three different peoples: 1) Arabs, 2) Wazungu (white people) from America, and 3) black Africans, called Mbonelakuti.

I eliminated Arabs and Wazungu from the list of potential smelters based on what I know about the history of eastern African. Their appearance in the local tradition has to do with slave trade which was widespread in this part of East Africa in the second half of the nineteenth century as noted in chapter 2 (see also Livingstone 1874).

Mbonelakuti (or Batwa) are often mentioned in the Bantu folklore (Clark 1950; Procter 1960; Rangeley 1963). They are said to have been "little people, hardly reaching to the waist of a man [Bantu person?], and they were very touchy about their small stature" (Rangeley 1963:37), hence their name (mbonelakuti = where did you see me?). Most traditions (including the Fipa) hold that these people had the knowledge of ironworking (Clark 1950; Rangeley 1963). The archaeological evidence discussed in chapter 8, however, does not support the claim that the katukutu technology was practiced by the Mbonelakuti.

Malungu Technology

Of the sixty-six ironworking sites, twelve had evidence for the malungu technology (Table 5.1). These included Hvlk-39 from Kirando (Fig. 4.2); Iall-1, 2, and 5 from Kala (Fig. 4.3); Ialm-1, 3, 4 and 5 from King'ombe (Fig. 4.3); and Hxlo-1, 2, 3, and 5 from Kalundi (Fig. 4.4).

The following is a summary of the characteristics of the malungu technology based on ethnographic inquiries and site survey. Additional properties, based on excavations, as well as laboratory analyses are presented in chapters 6 and 7, respectively.

Furnaces. The site survey yielded 32 smelting furnaces (malungu) and 34 refining furnaces (vintengwe) (Table 5.2). Twenty-one (66%) of the malungu were intact (still standing) while the remaining eleven had fallen by the time of this survey (1992-3). The distribution of malungu per site varied from one to twelve with a density ranging from 272 to 25000 square meters per furnace, averaging 0.8 furnace per hectare.

The shape of malungu can be described as truncated cones: wider at the bottom, ranging in internal diameter from 130-150 cm, and narrow at the top, ranging from 50-95 cm in internal diameter. The height also varied from 220-310 cm (measured from the base of tuyere ports). However, records of up to 4 m in height and 2.5 m in basal diameter are known from southern Ufipa (Greig 1937; Wembah-Rashid 1969). The wall thickness was reduced with height; ranging from 20-25 cm at the base and 8-12 cm at the top.

The walls consisted of 5-8 superimposed rings that marked the stages taken in building the furnaces (Fig. 5.7). The rings varied in breadth from 10-80 cm. Each furnace had a peep-hole, measuring 2.5-4 cm in diameter that was always located on the eastern side about 100 cm above ground. This was used to monitor smelting performance inside the furnace. The furnace exteriors had been plastered, but most of the clay had been washed off by rain after abandonment, leaving only a few marks. The interiors were reduced (black), but, in some furnaces, slag (sub-type C-m) was found hanging on the walls.

"Crack patching" and wall layering (noted in katukutu furnaces above) were not found in the malungu furnaces in Nkansi district. Some researchers, however, have recorded "furnace patching" among other malungu users, e.g. in southern Ufipa (Barndon 1992) and in Kasungu, north-central Malawi (Killick 1990). According to former smelters, a furnace could be used many times (up to 180 times, that is 15 seasons with 12 smelts per season) as long as it did not crack. A cracked furnace was either abandoned or dismantled and a new one built--sometimes at the same place to continue reusing ritual medicines (this claim was verified with excavation, see site lalm-4, chapter 6). Patching was avoided because of the risk of breaking during the smelting process.

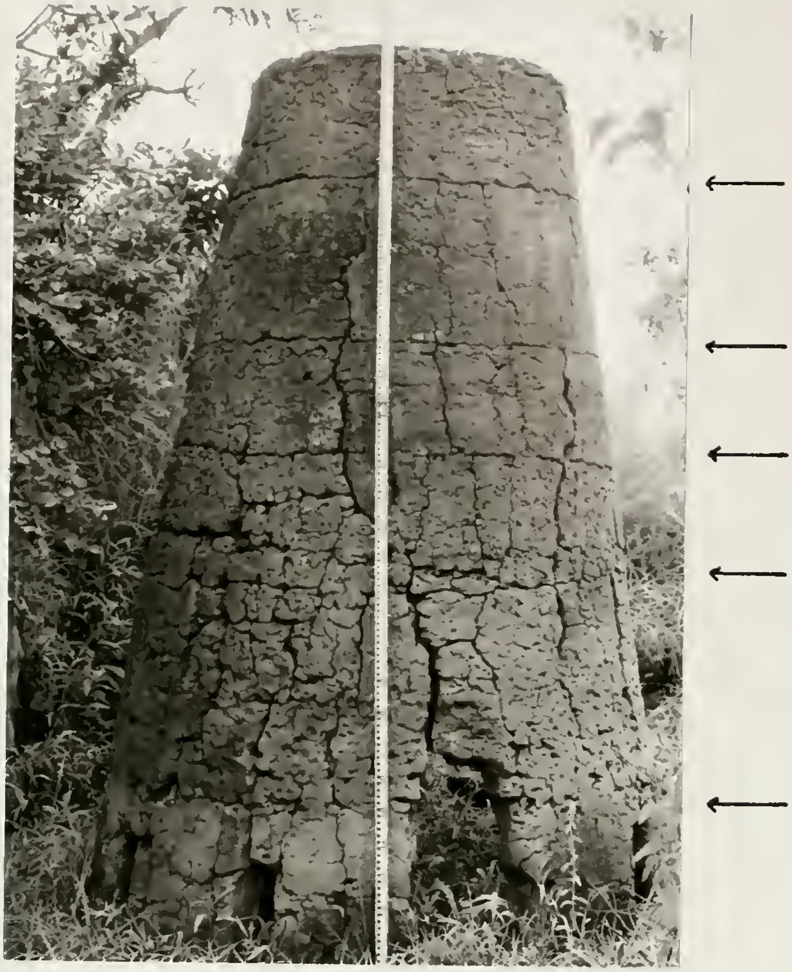

Fig. 5.7 Lilungu (F1) at site Hxlo-2, Kalundi showing construction rings.

Vintengwe were smaller and quasi-cylindrical in shape, measuring 35-50 cm in height and 30-40 in internal diameter (Fig. 5.8). Furnace walls were almost uniform in thickness varying only 2-3 cm from bottom to top, although we noted variation of 6 cm (i.e., ranging from 12 to 18 cm) in wall thickness between furnaces. Vintengwe had four openings, three of which each housed one tuyere that was connected to a bellow and the fourth opening was used for slag tapping. Thus, unlike malungu which operated by a natural draft, vintengwe were operated by forced draft.

Fig. 5.8 Kintengwe, site Ialm-1, King'ombe.

Tuyere ports. Ten trapezoidal openings spaced between 28 and 60 cm apart were located around the base of each lilungu. Nine openings were small and averaged 30 cm in height, 15 cm in basal width, and 10 cm in top width.

The tenth opening was larger, averaging 50 cm in width and 45 cm in height. Many students of African iron metallurgy might interpret this wider opening to be a "rake-hole"--a common feature in reused furnaces--used for extracting bloom, slag, and smelting residue from the furnace interior after smelting (Pole 1985; Kense 1985). But the emic perception of this opening as noted by Barndon (1992) and myself among the Fipa is that the name "rake-hole" does not cover the complete meaning of the opening. The Fipa smelters referred to the wider

opening as "palinyina",[1] meaning "maternal opening"--a name that emphasized reproduction symbolism, a central symbolic armature of indigenous African iron metallurgy (Schmidt in press). It should also be noted that palinyina openings were always located on the western side of the furnaces, which themselves were also always located on the western side of termite mounds. The reason for this is again symbolic rather than following "the force and direction of the...prevailing wind as a source of natural draft" as suggested by Childs (1991b: 342) and others (see discussion below under "Site Locations").

In the Fipa technological context, the wider hole (palinyina) was equated to the birth canal as opposed to the simplistic function of extracting smelting products and refuse. For this reason the term palinyina is preferred in this work to "rake-hole". This however is not to deny its technological function.

Tuyeres. There were many fewer tuyeres found in malungu sites compared to those found in katukutu sites. Complete tuyeres were shorter but wider compared to those used by katukutu iron smelters. They ranged between 22 and 30 cm in length, 4.9 and 7.6 cm in external diameter and 2.4-3.5 cm in internal diameter. Most often they were found in quadruples (a set coming from one port) cemented together with slag. Sets of

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[1] Some malungu (e.g., in Kalundi) also had of a "paternal opening", called palisi, placed directly opposite the palinyina and directly below the peep-hole. In some furnaces it was 10-15 cm wider than the other tuyere ports, while in others it was nonexistent or undistinguishable. For this reason it is often considered under the group of "ordinary tuyere ports" in the analysis. We did not find an analogous palisi on the katukutu furnaces.

three tuyeres per port were also noted especially in relatively short furnaces (2.3-2.5 m). We were told by informants that palinyina had twice (6 or 8) the number of tuyeres placed in the ordinary tuyere ports.

The number of complete tuyeres recovered was higher (82% of all tuyeres found) compared with only four tuyeres (less than 0.001%) in the katukutu sites. This seems to have been caused not only by the large size of the malungu tuyeres but also the fact that only small portions of the tuyeres (less than 10 cm) projected inside the furnace as compared with over 25 cm in katukutu furnaces (see chapter 6). This helped to minimize tuyere-collapsing during smelting.

Tuyeres were uniform in diameter from tip to tip; they were not flared. Vitrification was not as common as in katukutu technology, instead slag coating and clogging inside the tuyeres were common. Slag clogging was noted for 22% of the observed sample and slag coating on 43%. According to oral accounts, tuyeres used in the malungu had two functions. Those placed in the palinyina (rake-hole) were used mainly for slag tapping. They, however, would transmit air into the furnace in the first stage of the smelting process before a pool of slag formed at the bottom of the furnace. As soon as this slag reached the level of the tuyeres (which averaged 30 cm from the floor) they assumed a second function: they conducted the slag outside the furnace. For this reason, tuyeres at the palinyina were placed at an angle, sloping downward from the interior to the exterior. The remaining tuyeres were placed horizontally

and were used principally for conducting air inside the furnace. The horizontal position also allowed some occasional clogging or slag coating in the interior.

One should note that this observation contrasts with Barndon's claim that all tuyeres were placed at an angle similar to that explained for palinyina above (see Barndon 1992, Fig. 4.17, p.75). With the arrangement claimed by Barndon, all tuyeres would be used for slag tapping (she, ironically, denies that this was practiced) and the whole furnace would be surrounded with slag during operation.

Tuyere reuse was also practiced by the malungu iron smelters, although for a different reason than air draft or slag tapping. Old tuyeres, as well as rejects from fresh tuyeres were broken into short pieces (15-25 cm long) and placed inside the furnace at each port to support the tuyeres that projected inwards 2-10 cm. In site Ialm-1, where both malungu and katukutu technologies were evident, we noted that the malungu smelters also reused katukutu tuyeres for this purpose.

Slag: This was the most abundant material at both the smelting and refining sites and included all three slag types defined above. Slag from the two processes (smelting and refining) were distinguished by morphology, size of individual pieces and heaps, color, luster, heap composition, and provenance. The smelting slag consisted mainly of "cakes", stringers, blobs (round or amorphous pieces) and tuyere molds (clogging slag that solidify inside tuyeres), whereas refining slag lacked the last two shapes. Slag size revealed differences

in that the smelting slag generally consisted of large pieces. For example, the largest "cake" piece recovered from a smelting site measured 40X35X6 cm, and the longest finger measured 22X3X1.5 cm, whereas the largest cake from a refining site was 11X7X3 cm and the longest stringer measured 10X1.5X1.0 cm. The color and luster differences revealed that smelting slag was generally black in color and had a powdery or sooty surface, whereas refining slag was dark-brown and had a smooth, glassy luster. Finally, differences in provenance was easy to determine in the field due to the presence of associated materials especially furnaces. Additionally, the size of refuse heaps and the homogeneity of heap composition also varied and became diagnostic characteristics. Heaps of smelting slag were generally large and heterogeneous in composition consisting of slag of various shapes and tuyeres (bundles and singles), while heaps of refining slag were homogeneous, composed mainly of fingery slag and some flat "cake"-blocks, very few tuyere fragments and no tuyere bundles.

Iron ore. Surface observation did not yield any ore, but excavation did, see chapter 6. With the help of former smelters, however, we were able to find sources of ore they used in the beginning of this century. The findings are presented below under "Ore Sources".

Site size and location. Smelting sites ranged in size from 900-8500 square meters (except site lalm-1 which also had katukutu sites measured 20,000 m^2). Smelting sites were located within a distance of 400 m from water sources such as

swamps, rivers, and lakes. In both King'ombe and Kalundi, smelting sites were located in forested areas (which assured fuel and privacy) and within 2500 m of ore sources. The most exploited trees included Mbula (Parinari curatellifolia), Msuku (Uapaca kirkiana), and Msumbu (Brachystegia manga).

Furnaces were always located near termitaries. This had both technological and religious (symbolic) values. The technological significance refers to easy access to clay. This is testified by oral tradition, as well as by the presence of borrow pits next to each furnace. But unlike the katukutu technology which had more than one furnace per termitary, there was only one furnace found per termitary in the malungu technology (two furnaces per termitary have been reported in Zambia (Childs 1991b)). Smelting furnaces were located at the base of termitaries and always in a westerly direction varying between 258 and 300 degrees. Several explanations have been attempted by previous researchers. Based on her observation of iron smelting furnaces in central Zambia, Childs posits that the furnaces "were always located on one side of large termite mounds to utilize the prevailing wind as a source of natural draft" (Childs 1991b:342). I find this hypothesis to be shaky because the prevailing winds during the smelting season (July-October) is southeasterly. The western side is, therefore, disadvantageous because it is obstructed by the termitaries.

According to Barndon, who conducted an ethno-archaeological study in southern Ufipa, the western direction has a historical significance. She writes;

> Informants claimed the generic term assigned the chimney furnaces; iluungu relates to the Ulungu country west of Ufipa. ... The iron smelting furnaces are ... placed sloping slightly downwards with the main tewel opening facing west towards Ulungu country (Barndon 1992:117).

Although this sounds like reasonable explanation, it has one weakness. Ulungu country (northern Zambia) mentioned by Barndon here is located southwest of Ufipa and not directly west. When we asked informants who believe in the Ulungu origin[2] to show us where their ancestors came from, they pointed to the southwest. But the compass readings of the smelting furnaces vis-a-vis respective termitaries taken during this research project varied between 258 and 300 degrees with a mean of 269.4 degrees. This indicates that the furnaces were placed very close to magnetic west and definitely not southwest.

This question was followed-up during this research project. According to former smelters, the western direction was selected because "that is where the sun sets"[3]. When we asked about the connection between sunset and ironworking the informants said that they did not know. "That is what I was told, and we believed. We did not want to know more", Mzee Minango concluded. The "sunset" idea was an important insight. It indicated that the answer could be found in the realm of Fipa

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[2] Several other theories exist, including originating in Ufipa, coming from the east, north, or descending from the sky (see also Willis 1981).

[3] Paulo Minango, interviewed in a panel with Xavery Mwanakatwe and Noel Orabi at Kalundi, February 1993. See appendix A for annotations.

world view and cosmology and not technology per se as initially thought.

Barndon (1992) and myself, as a result of this research, have noted that the Fipa conceptualize their environment and culture with an elaborate bipolar world view: male vs female, white vs black, life vs death, east vs west, sunrise vs sunset etc. More important, these opposite poles are given gender values. For example:

MASCULINE	FEMININE
man	woman
white	black
life	death
head	waist
day	night
sun/stars	moon
sunrise	sunset
east	west

This binary polarity and their gender roles are also observed in furnace construction and iron technology in general as Barndon notes:

> The tewel opening on the chimney furnace is called the "mother door" (palinyina) and placed facing towards west and sunset. Opposite, towards east is the "father door" (palisi). Above the "father door", the peeping hole (ntaanda) is placed. The "father door" (palisi) is thought to give strength to the furnace by it's location towards sunrise and by working together with the peeping hole "ntaanda" which represents a star. The "furnace caretaker" (umpakasi), the head of a white cockerel (unntwe wa unnkhoko) is placed at the base inside the furnace chamber also facing east, and is expected to mature and crown [crow?] during the smelting (Barndon 1992:117, emphasis, underlining, is mine).

From this we can conclude that the western direction was selected both for location of smelting furnaces and the palinyina because of its cultural/symbolic significance to the Fipa and the strong relationship between iron smelting and human reproduction. The furnaces symbolized a woman in labor, "sitting" in the western (feminine) side of the termitary with the birth canal (palinyina) through which the newborn (bloom) would come also facing west.

This symbolic reconstruction is supported by another tradition from local healers and old women[4] who affirmed that traditionally, when a Fipa woman was in labor she was positioned (lying) such that her head (masculine) would face east (masculine) and the lower body, from where the newborn would come, would face west (feminine).

Vintengwe, on the other hand, were not oriented to a specific direction, although they were almost always located on the sides of termitaries (Fig. 5.8) or mound-like structures in order to facilitate slag flow and obtain clay for furnace construction. The number of vintengwe per termitary varied from one to four. We also observed a preference to locate vintengwe close to smelting sites. Of the 34 vintengwe found during this research, 27 (79%) were located within 250 m of the nearest smelting furnace; the remaining were located within 100 m of the nearest house (judging from concentrations of daubs and potsherds).

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[4] Monika Nkana (60), interviewed in a panel on October 24, 1992 and Mama Ana (57), interviewed alone on February 20, 1993 (see appendix A for annotations).

Spatial distribution. Based on this research and that of others (Wright 1982; Killick 1990; Barndon 1992), the malungu was mainly a plateau technology, "arching from the Chishinga country on the plateau east of the Luapula river in Zambia, northward to Rukwa and Ukonongo in Tanzania, and then eastward and southward into Malawi and eastern Zambia..." (Wright 1982:2).

We noted on table 5.2 that two smelting furnaces (one at Kirando and the other at Kala) and five refining furnaces (all at Kala) were found along the lake shore during this research project. This was a perplexing find which generated several questions. Fortunately, both oral history and traditions provided answers. According to these sources, the few malungu furnaces found today along the shore were built by immigrants from the plateau. We noted in chapter 2 about the fluctuation of Lake Tanganyika and its effects on land use pattern on the shore dwellers. In the 1870s for example, the lake was about 6 m above the present level (D.D.Y. 1957). However, by the end of the nineteenth century the water level in Lake Tanganyika decreased significantly resulting in land reclamation including a large part of the Kirando plain (D.D.Y. 1957); Manyesha 1988). Consequently, a large number of people from the plateau immigrated into the shore area. These people relied largely on the plateau for iron and iron implements. Some of the newcomers, especially those who belonged to the iron smelting clans, tried to manufacture their own iron along the shore using

the malungu technology. This, unfortunately, did not work. Accounting for this phenomenon, Rev. Manyesha says:

> ... before the lake receded exposing this plain [Kirando] people lived on the plateau. ... When they arrived in this land they tried to built "MALUNGU" (iron smelting furnaces) for forging hoes, axes, and spears as they had been doing at their home, the Fipa plateau. But it seems there was no iron ore [bog ore, may be?] in the ground as in the plateau. This work, therefore, did not live long (Manyesha 1988: 2, the translation from Kiswahili is my own).

This research has shown that the technology was short-lived not only because of lack of bog ore as Manyesha argues, but, and principally, because of the influx of European metalware brought by the White Father missionaries. The lilungu (sing. of malungu) found at site Hvlk-39 at Kirando, is, therefore, one of the trial smelts conducted by the immigrants.

A different account, however, was given for the smelting furnace and its kintengwe found at site Iall-1 at Kala. Oral traditions hold that these were constructed around the end of the last century by smelters from Kitanda (west of King'ombe) a site 10 km to the east following a request by the early missionaries who wanted to know how Fipa iron production was operated. The remaining four vintengwe at Kala (sites Iall-2 and Iall-5) were constructed and used during the beginning of this century by some immigrants from the Fipa plateau. Informants testified that these people used to return to the plateau (following resources especially iron ore and wood) to

smelt iron seasonally and come back with pre-refined blooms and then refined them at Kala.

Relative chronology. Fipa people claim a long tradition of iron-smelting. Genealogical reconstruction of the Milansi chiefdom, one of the two important chiefdoms during the end of the last century and the beginning of this century, places the origin of iron and the Fipa people around 1700 A.D. (Willis 1968, 1981). Willis also suggests that the malungu technology started during that time. However, C14 dates from this research point to a more recent date for malungu technology (see chapters 6 and 8).

Additionally, site Ialm-1 provided a clue for the relative dating of the malungu and the katukutu technologies. Two malungu had been tempered with tuyere fragments and slag belonging to the katukutu type of technology (Fig. 5.9). This indicated that at least these two malungu were built after some katukutu furnaces existed[5].

5 This has been confirmed by C14 dating. The dates indicate that malungu furnaces are 100-300 years younger than katukutu furnaces (for more details see chapters 6 and 8).

Fig. 5.9 Lilungu (F1) tempered with katukutu slag and tuyeres fragments, site Ialm-1, King'ombe.

Barongo Technology

Of the sixty-six ironworking sites (Fig. 4.1), three were representative of the Barongo-type technology (Table 5.1) and all were located at Kirando. These included Hvlk-35, 36 and 60 (Fig. 4.2). The technology observed at these sites bears a strong resemblance to that practiced by the Barongo people in Mwanza Region to the north (de Rosemond 1943; Schmidt in press), hence the name "Barongo-type". Both ethnographic inquiries and site

survey revealed the following characteristics for this technology:

<u>Furnaces.</u> None of the sites revealed a standing furnace; only chunks of burnt clay that were broken furnace walls were found. The walls ranged in thickness between 8 cm and 12 cm. Both height and diameter of the furnaces could not be estimated because the furnace slabs were too fragmentary. But Rosemond (1943) and Schmidt (in press) observe that in southern Lake Victoria the Barongo furnaces measured 60-90 cm high. By estimating the amount of furnace rubble based on the information from other localities with the Barongo-type technology (Rosemond 1943; Schmidt in press) we could, however, tell that there was at least one furnace per site. The furnace pieces were not vitrified inside but generally oxidized (having orange-red color). Some blocks of granite measuring up to 40X26X20 cm in volume were found in association with some pieces of burnt clay in the middle of the site.

<u>Tuyere ports.</u> It was not possible to study tuyere ports because the furnaces were dismantled. Schmidt (in press) observed five tuyere ports in Mwanza region.

<u>Tuyeres.</u> There were fewer tuyere remnants at these sites than at the sites of the other two technologies. Surface investigation revealed 43 pieces weighing 754 gm. There was no complete tuyere found, thus the maximum length of the tuyeres is not known. Tuyeres varied in external diameter from 4.1-5.4 cm and in internal diameter from 3.0 -3.5 cm.

Some end pieces were flared indicating that a bellow was probably used. The flared parts were either plain or sometimes oxidized, while the opposite tips were slag coated on the exterior and minimally vitrified. The recovered pieces were too small to be used for estimating the portion which projected inside the furnace.

Slag. This was the most abundant material at Barongo-type sites. The slag consisted mainly of types B-n (molten, amorphous, and dense); B-m (amorphous, rough on the surface, metallic and displaying either charcoal impressions or charcoal entrapments); and a few pieces of type C-m (pumice-like). There were no long fingery flow slag as those found at the malungu sites. Large "cake" pieces (Type B-m) were also common, measuring up to 18X14X12 cm and weighing 2800 gm.

Iron ore. There was no ore recovered at these sites.

Site size and location. Sites ranged in size from 150-1200 square meters. Unlike the other two technological types which were located adjacent to termite mounds, sites of this type were located in a varied topographic environment with no relationship with termite mounds. Sites Hvlk-35 and Hvlk-60, situated one km from each other, were located on the slope of a ridge overlooking the Luafi river 100 and 400 m respectively to the south. Site Hvlk-36 was found 12 km north of the other two and was located on a plain land 100 m west of the Makoba rivers. The absence of association with termite mounds suggests that the Barongo-type technology was practiced by

people with different beliefs from those of the katukutu and malungu technologies.

Spatial distribution: So far, no site has been reported south of Kirando. We can, therefore, tentatively say that the technology extended between Nkansi District (Rukwa Region) to the south and southern Lake Victoria (Mwanza Region) to the north.

Relative chronology. Although Schmidt (in press) notes that this technology was still in practice in Mwanza Region until the middle of this century the elderly informants at Kirando denied seeing any people practicing this type of ironworking in their lifetime. This suggests that the "Barongo" iron workers stopped making iron or abandoned the area before the contemporary inhabitants of Kirando arrived from the plateau and other places around the end of the last century. This is supported by chronometric dating (see chapters 6 and 8).

Ore Sources

Site survey and ethnographic inquiries revealed four ore quarries which had all been used until the beginning of this century. Two sites (Hvlk-28 and 29) were found at Kirando, one site (Ialm-2) at King'ombe, and the last (Hxlo-4) at Kalundi.

Site Hvlk-28 was a quarry for lateritic ore located on the northern margin of Matopeni valley (Fig. 4.2). It measured 5.20 m in diameter and 1.5 m in depth (including a 0.5 m layer of soil

deposited after abandonment). At the time of the survey we found some blocks of laterite placed around the rim.

Site Hvlk-29 was situated on a ridge 700 meters west of Luafi bridge and 260 meters north of Namanyere road (Fig. 4.2). It consisted of three heaps of lateritic gravels measuring 40 cm high and 80-90 cm wide at the base. These seemed to have been quarried for ironworking but for some reasons were not transported to a smelting site.

Site Ialm-2 was a natural basin filled with water during the rainy season, and is called 'Kitanda,' meaning "a small lake" in Kifipa. It was located about 1.5 km east of site Ialm-1 and extended 20-120 m north of the Kala-King'ombe track (Fig. 4.3). According to local accounts, the swamp was used as ore source for all malungu sites found around King'ombe. We could not examine the old quarries because the basin was flooded when we investigated the site in February 1993.

The last site, Hxlo-4, consisted of the entire basin west of Kalundi village. This investigation revealed many pits, some measuring up to 20 m wide and two meters deep, distributed all over the basin. There was a high concentration of pits at the site center, that is, directly east of site Hxlo-2 (Fig. 4.4). We assigned one former iron worker to collect some ore, but he could not obtain quality samples because there was excessive water in the area during the rainy season (Fig. 5.10).

All these quarries seem to have been used by the malungu smelters because none contained hematite or magnetite, the type of ore found at katukutu smelting sites. According to local

informants, magnetite (in Kirando at least) could be found along the upper courses of the rivers Luafi, Mpasa, and Kavunja near the bases of the Chabya and Mosi-wa-Mpepo hills (Fig. 4.2). Our investigations in these river courses yielded 8 magnetite[6] gravels, three along the Kavunja river, four along the Mpasa, and one along the Luafi, but no specific quarry was identified. Probably the katukutu smelters also relied on the river beds for ore sources.

Fig. 5.10 Mzee Xavery Mwanakatwe (a former smelter) digging for iron ore at site Hxlo-4, Kalundi.

Habitation Sites

Figure 4.1 shows that 13 sites found during this research project had evidence for habitation. The evidence used to

6 Analyzed at the Geology Department, University of Dar es Salaam.

determine this category of sites included features such as architectural structures and rock-shelters; artifacts such as daub, pottery, beads, tobacco pipes and gourd sherds; and faunal remains.

Architectural Structures

This category was represented by one site, Hvlk-8. The site consisted of ruins of an old missionary compound situated on a hill top overlooking Lake Tanganyika 200 m to the west and the Old Jiwenikamba village to the north. Buildings that were still standing include a church, two dormitories--one for priests and the other for nuns (based on oral testimonies)--and a fortress measuring 200 m by 200 m and 1.5 m high. Three graves were also found inside the fortress. The church was more than a century old, being built in 1888 (Manyesha 1988). This historically important structure was left unattended, and bushes and trees were threatening its future survival. By documenting it as a site, we intended to bring it to the attention of the people concerned (especially cultural officers) so that they might take appropriate conservation measures[7].

[7] Two of our survey crew members worked with the Ministry of Culture and Education, one from the Antiquities Unit, Dar es Salaam, and the second from the Cultural office at Sumbawanga. Both were assigned to report the matter to their respective officers in charge of conservation (hopefully they reported and proper measures have been taken).

Cave-Shelter

There was one site (Hvlk-19) in this category located about 10 km southeast of Masolo village along the Lusambu river. The cave (Fig. 5.11), which according to oral accounts had been used for generations, was still being used as a seasonal camp by hunters, honey collectors, and fishermen when we visited it. We found several utensils, including water gourds, cooking pots, and flour-storage pots (some with flour in them), as well as animal hides (used as sleeping mats) in the cave. The site was later excavated (see chapter 6).

Fig. 5.11 Cave shelter, site Hvlk-19, Kirando.

Sites Represented by Artifacts and Faunal Remains

Before going any further in this sub-section, it is important to point out that surface occurrences of materials such as daub, potsherds and animal bones are commonplace in

the countryside of Tanzania following the villagization policy of the 1970s[8]. Settlement sites recorded during the survey were only those that were more than a century old. The age was determined through ethnographic inquiries, wear and weathering of artifacts and ecofacts, and pottery attribute comparison with dated findings from other sites in East and Central Africa.

This category was represented by eleven sites, including Hvlk-5, -6, -7, -11, -26, -35, -36, -47, -56, -57 and -58 (Fig. 4.2). Dominant cultural materials included daub, faunal remains, and pottery. Four of the habitation sites, including Hvlk-11, -26, -57 and -58 were unique in terms of quantity, variability, and age of materials and were, therefore, excavated. Their detailed descriptions including geographical location and specific findings are given in chapter 6.

Daub. This was distinguished from natural or other type of clay by having post impressions. Concentrations and scatters of burnt daub on the ground were located at two sites, Hvlk-11 and Hvlk-58. Both sites were excavated (see chapter 6)

Faunal remains. Low density scatters of animal bones were found at most habitation sites. High density scatters and concentrations of faunal remains were limited to three sites: Hvlk-5, -11 and -58. The remains from site Hvlk-5 were

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8 The central government in Tanzania launched a resettlement scheme in 1974 through which concentrated settlements were established by amalgamating smaller and scattered settlement units. In Kirando, for example, where more than 20 settlement clusters existed prior to this scheme there are only five concentrated villages today. These include Masolo, Kipili, Mtakuja, Katete, and Kerenge (Fig. 4.2). Some people today return to their old residences (where their farms are) to guard their crops from wild animals such as wildpigs and baboons.

principally of domestic cattle (<u>zebu</u>), together with potsherds and ash heaped at the base of a termite mound. These materials suggest that the place had been used as a dump by early inhabitants. Oral testimonies, as well as the pottery types found, suggest that the site was abandoned by the end of the last century. Site Hvlk-11 consisted of <u>zebu</u> as well as buffalo and hippo remains, while site Hvlk-58 consisted mainly of <u>zebu</u> and buffalo remains.

<u>Pottery.</u> These were the most ubiquitous materials at the habitation sites. Five different traditions have been recognized based on attribute comparison within the research area and between the current research area and other sites in East and Central Africa. Other criteria used to determine types include superimposition of the pottery revealed from excavations as well as C14 dates from excavated sites (discussed in chapter 6). The five traditions include Kalambo; Triangular Incised ware--TIW; Ivuna; Katukutu; and recent (Kirando and Tabwa) pottery.

<u>Kalambo Tradition.</u> The name is derived from the type site, Kalambo Falls, located 70 km south of Kala, along the Tanzania-Zambia border. The site was excavated by J. D. Clark in the early 1960s (Clark 1974). In Kirando, Kalambo pottery were found at sites Hvlk-6, -11, -26, -56, -57,- and -58.

Kalambo pottery is characterized by open bowls and globular pots most of which are undecorated, while decorated pots are dominated by simple decorative techniques, such as grooving and channeling, hatching, and stamping. Additionally,

it has false relief chevron designs and beveled rims that are often externally thickened (Fig. 5.12). It has a medium paste and is tempered with quartz. Most pots are rough inside and smooth outside; the remaining are either roughly finished on both interior and exterior surfaces or are smooth inside and out. They appear in buff or brown color.

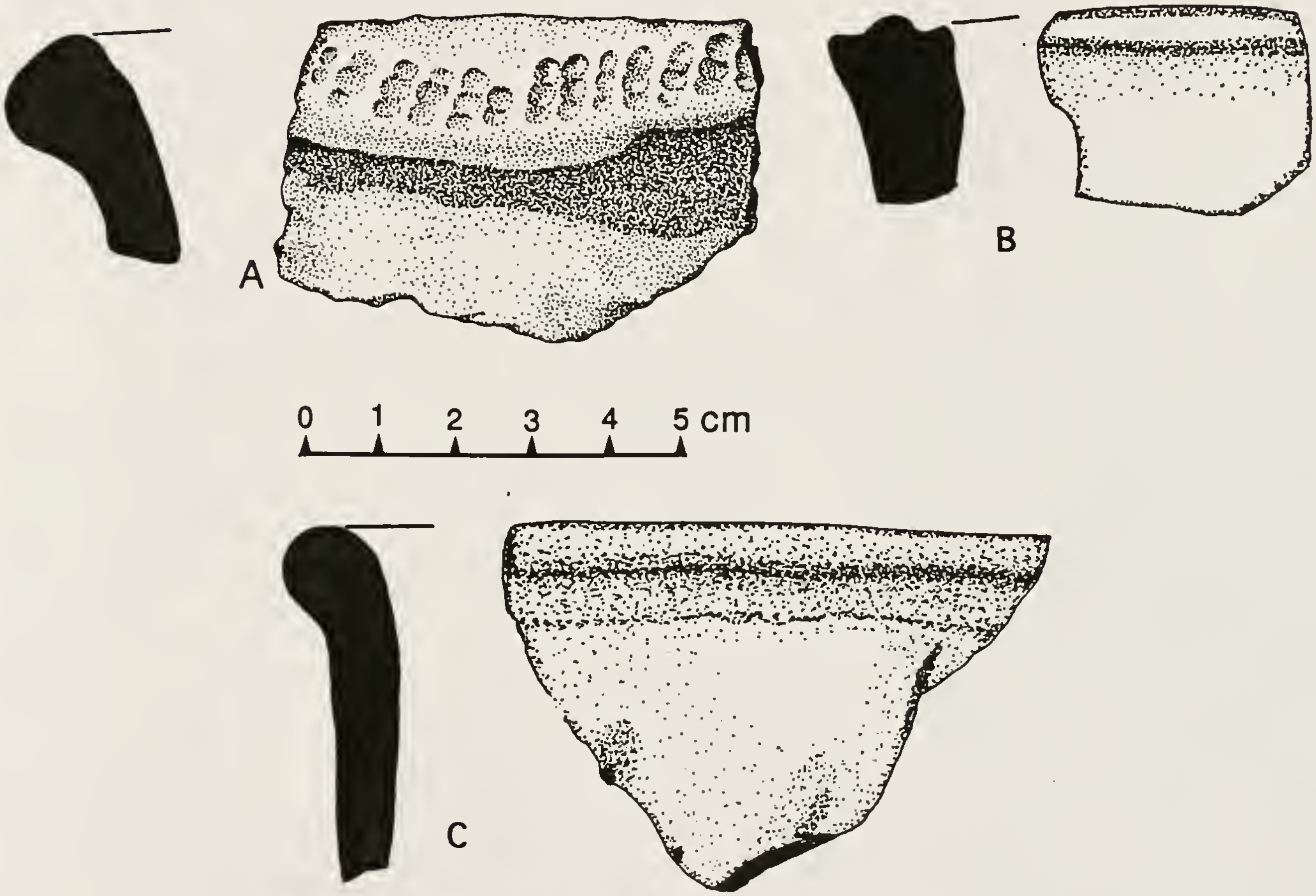


Fig. 5.12 Kalambo pottery

Clark's excavations at Kalambo Falls showed that the Kalambo tradition dates between the fourth and the eleventh centuries A.D. (Clark 1974). The current study has yielded one C-14 date from a charcoal, site Hvlk-58, Kirando, taken from the context of both Kalambo and TIW pottery. It dates to the tenth century A.D.

<u>Triangular incised ware (TIW).</u> This type of pottery is commonly reported from the east African coast and is known by various names (e.g., Tana, Wenje, Type C, etc.). It dates between the seventh and the thirteenth century A.D. (Chami 1994). In the Lake Tanganyika shore, TIW pottery was found at sites Hvlk-11, -47, -56, and -58.

The pottery included in this category consists of medium to small pots and bowls and a few large globular pots. These vessels are made of fine to medium clay and tempered with quartz and calcitic grits or gravels. Most of the medium and small vessels are burnished outside and/or inside, but large vessels are plain. Over 80% of the rim- and neck-sherds are decorated, and among these about 70% of them are decorated on the rim tops. The dominant decorative techniques include cross-hatching, incising, grooving, and stamping. These are applied in different combinations to form various motifs, the dominant of which include bands of triangular incisions or cross-hatches (diagonal or vertical) bordered with horizontal grooves or bands of diagonal incisions bordered with curvilinear grooves, horizontal lines, or punctates (Fig. 5.13).

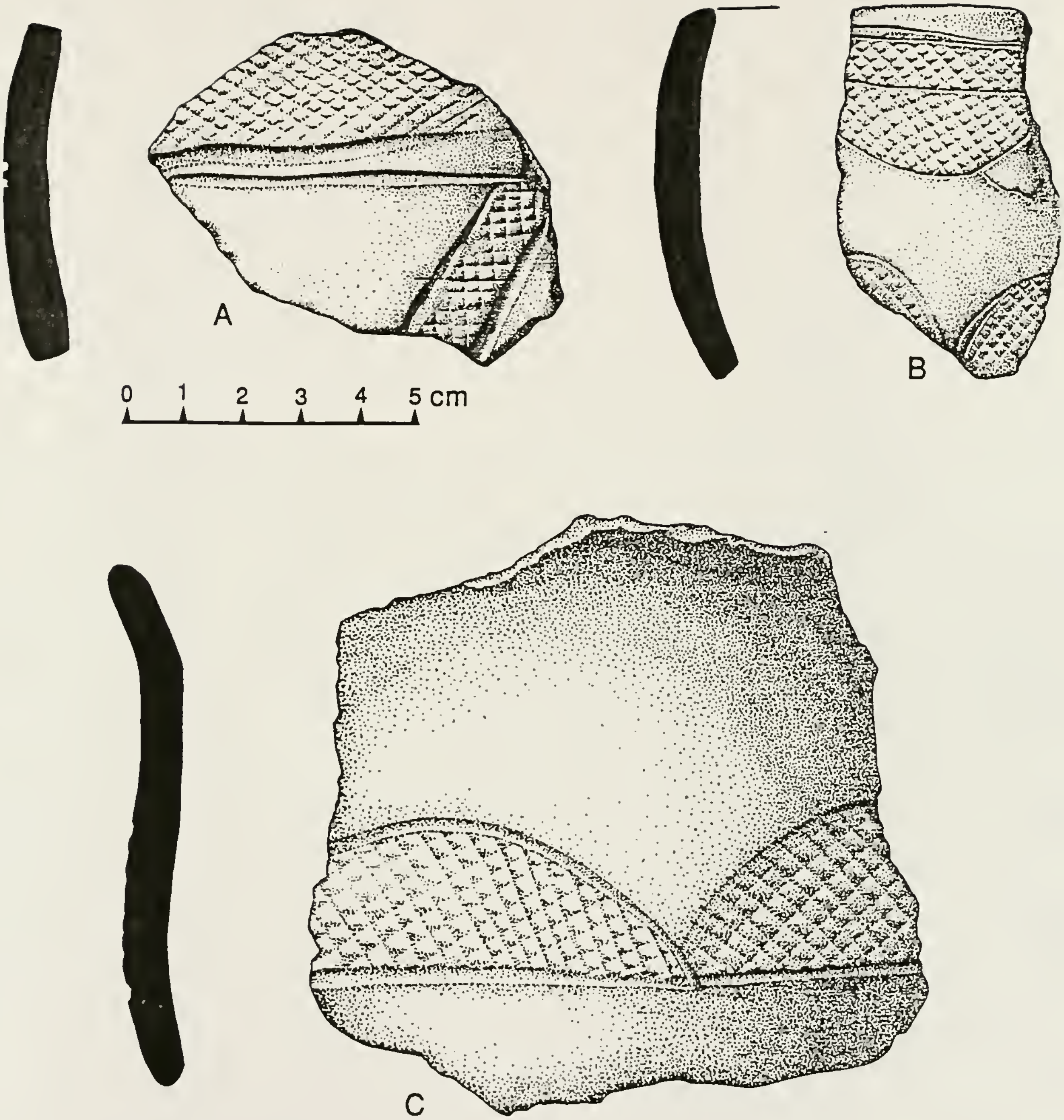
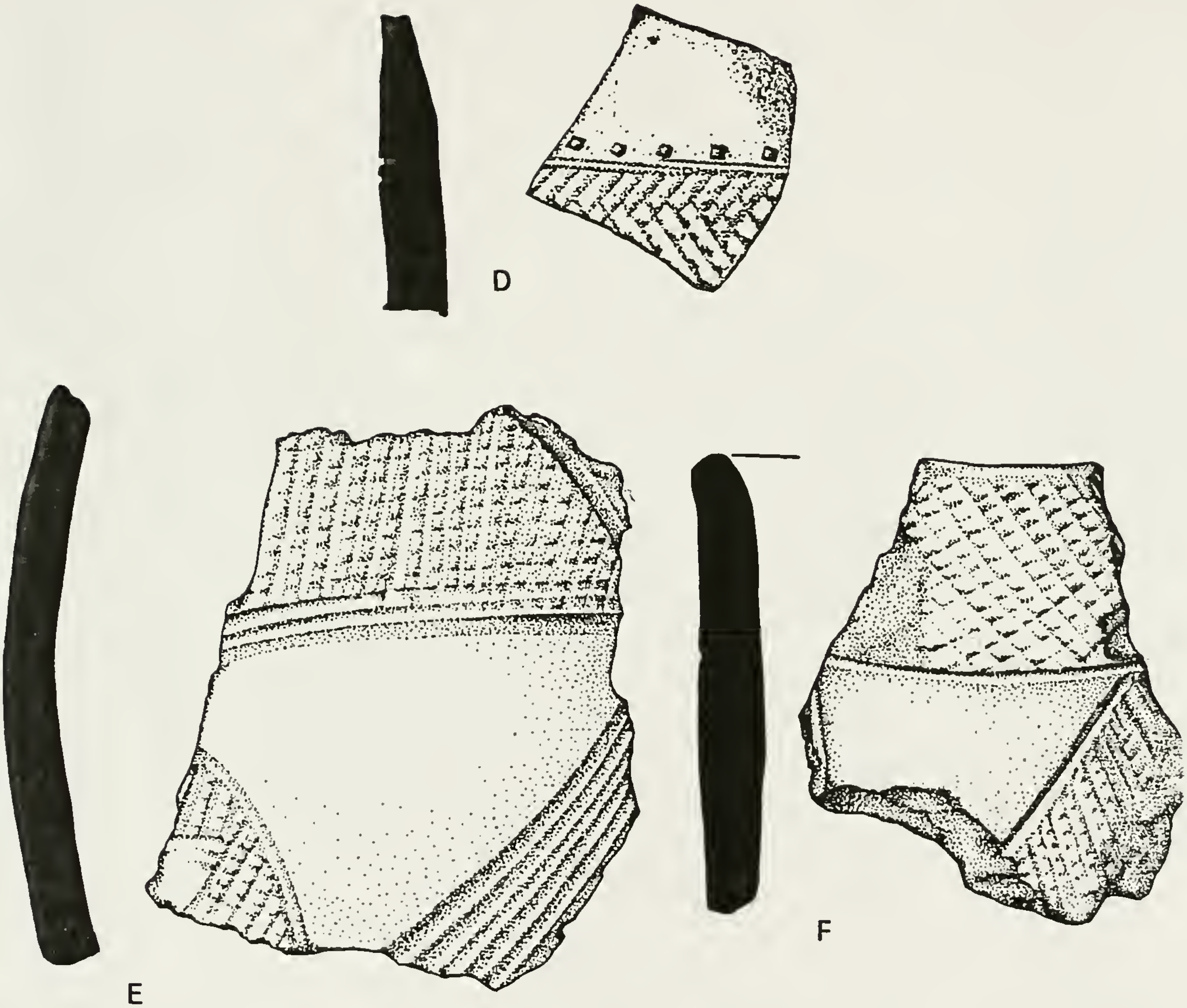


Fig. 5.13 TIW Pottery

Fig. 5.13 (TIW pottery) continued



Ivuna Tradition. Pottery of this category has a great affinity to the pottery found by Fagan and Yellen (1968) during their excavation at Ivuna in the 1960s. It was found in large quantities at sites Hvlk-11, -56, and -58.

The assemblage consists of medium to large hemispherical and open bowls as well as globular pots. Most pots are crosshatched or comb-stamped around the shoulder and the neck, and few also on the lip. The unique feature of this pottery tradition, however, is the presence of bumps or longish wavy or horizontal applications (ridges) around the shoulder. Some of the ridges are decorated with chevron, deep crescent-shaped punctates, or pronounced roulette applications (Fig. 5.14). The paste is fine and compact tempered with quartz. The exterior side is smoothened while the interior is generally rough.

No date has been obtained from the Lake Tanganyika shore, but the Ivuna pottery from the Lake Rukwa basin date between 1200 and 1400 A.D. (Fagan and Yellen 1968).

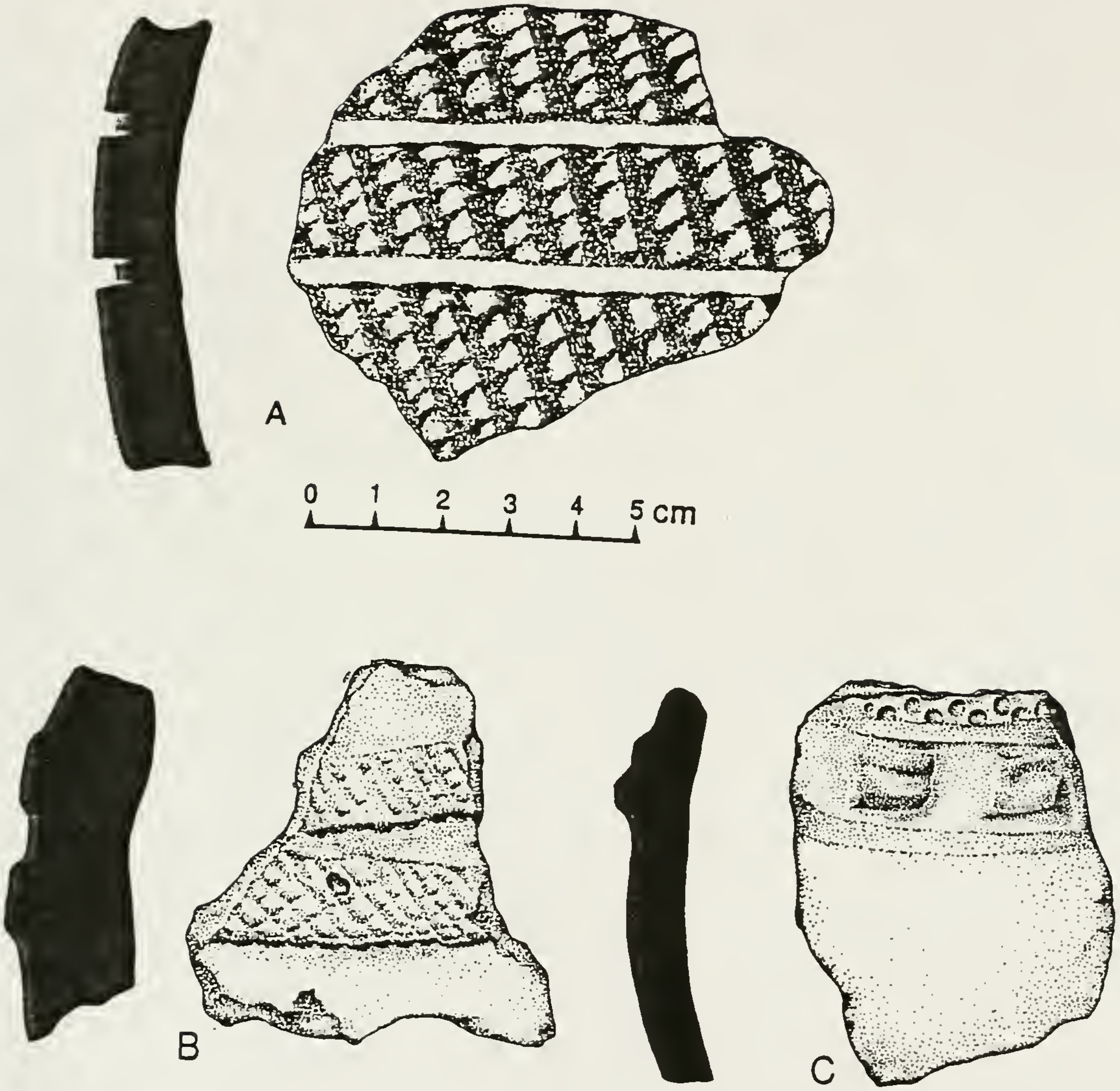


Fig. 5.14 Ivuna Pottery

Katukutu Tradition. Almost all pottery excavated at the katukutu sites belong to this tradition, hence its name. In addition to ironworking sites, katukutu pottery was found at sites Hvlk-11, -19, -47, -56, and -58.

This pottery tradition is dominated with large-to-medium jars, hemispherical bowls, and globular pots with vertical or out-turned rims. The medium-size jars and hemispherical bowls were used mainly for ritual for purposes inside the furnaces, whereas the other types were found outside the furnace, they had probably been used for utilitarian (non-ritualistic) functions. Most of these vessels are undecorated. The motif of those that are decorated consists of bands of parallel groves around the neck and cross-hatches on the lips (Fig. 5.15). A few pots have red pigment on the outside and are burnished inside, while the rest are smoothened on both sides. The pots have a fine paste, tempered with quartz. Katukutu pottery ranges in age from the mid-sixteenth century to the end of he eighteenth century A.D.

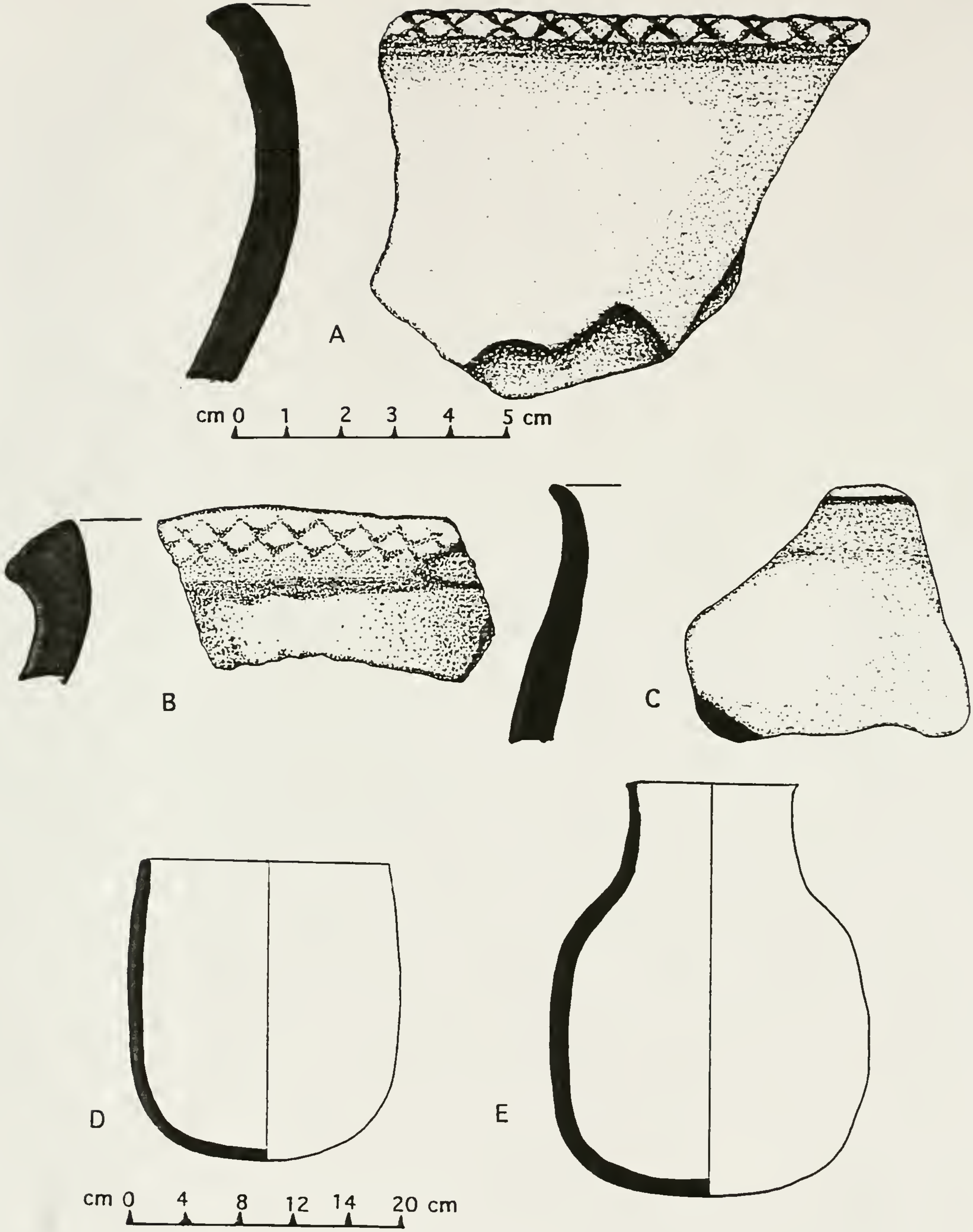


Fig. 5.15 Katukutu Pottery

Recent pottery. This category includes pottery dating from the nineteenth century to the present. Recent pottery were found in almost all habitation sites. The pottery belong to two different traditions: Kirando and Tabwa.

Kirando pottery is local and shows some derivative relationship with the katukutu tradition. It is dominated with large globular pots, small (cooking) pots, and open bowls with out-turned rims. Almost all vessels are decorated either on the shoulder or on the neck. Decoration motifs include diagonal incisions bordered by curvilinear bands of incisions and inclined incisions (left to right) below the neck without bordering (Fig. 5.16). They are commonly tempered with grog and quartz gravel.

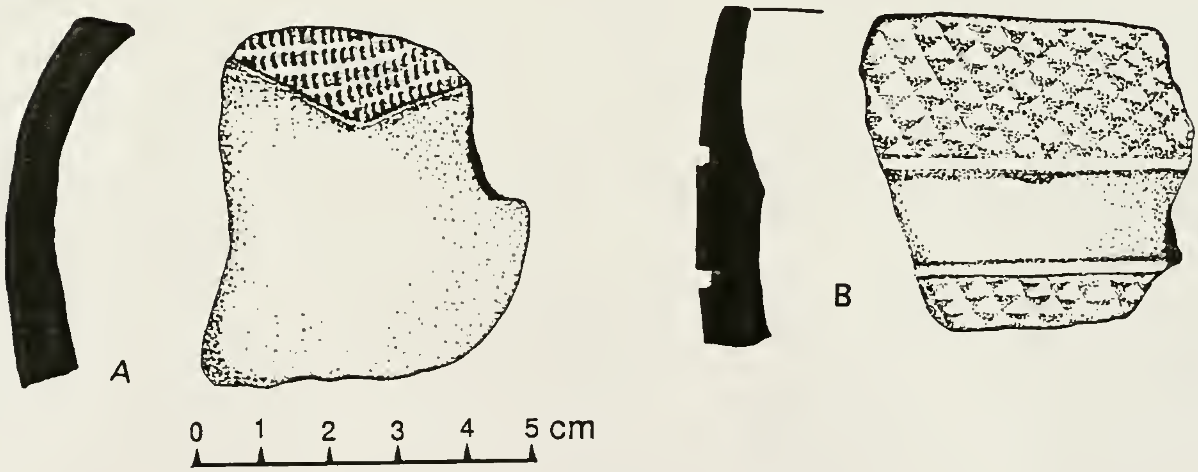


Fig. 5.16 Kirando Pottery

Tabwa pottery is either imported or made by Tabwa immigrants (from Zaire) along the shore. It consists of small carinated pots, and open bowls with vertical rims. All rims are rounded and up-turned with a slight flaring towards the exterior. About 30 % of the vessels have a red slip on the outside. Almost all vessels are decorated some around the shoulder and others on the rim, but not lips. The decorations include cross-hatches bordered, both top and bottom with single horizontal channels or curvilinear incisions (Fig. 5.17). The paste is fine and compact, some consisting of mica and tempered with quartz. Almost all pots are burnished in both sides.

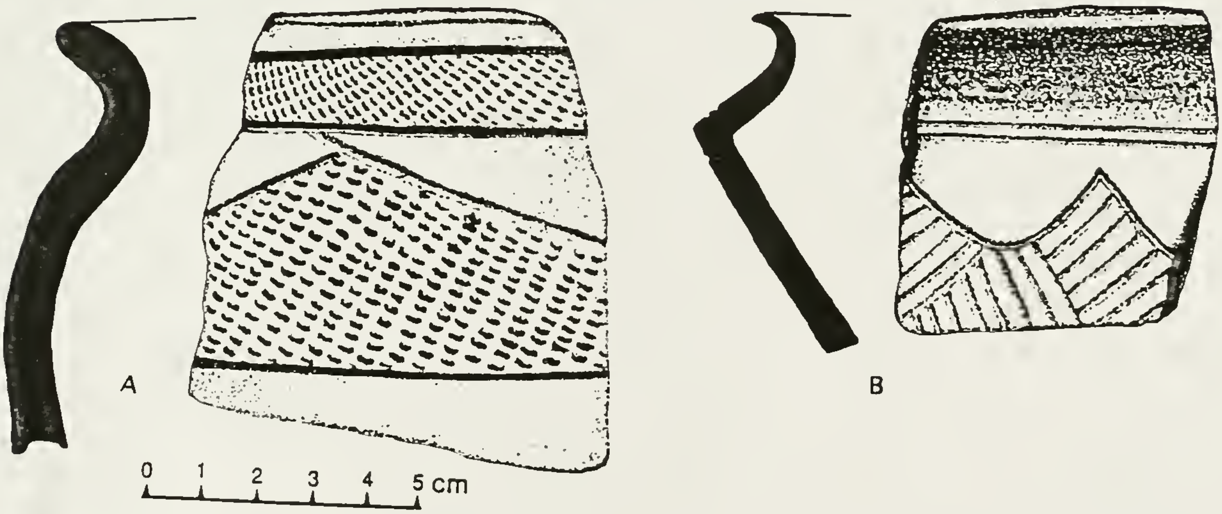


Fig. 5.17 Tabwa pottery

Source of Potting Clay

This category was represented by only one site, Hvlk-37. A cluster of clay quarries was found on a wooded ridge about one kilometer north of the Luafi river, northeast of Masolo village (Fig. 4.2). Informants claimed that the site was more than two generations (>50 years) old.

Ritual Sites

This category was represented by four sites: two (Hvlk-4 and Hvlk-30) located in Kirando, one (Hxlo-5) in Kalundi, and one (Iall-3) in Kala. The first three sites were similar in two ways: first, they were used for the same function of healing individuals; and second, they were still being used when we visited them in 1992-3. The last site dealt with human sacrifice aimed at purifying the society. This practice was stopped by Christian missionaries in the beginning of this century.

Healing for Individuals

Site Hvlk-4, Kirando. The site consisted of two locales, A and B. Locale B had evidence for ironworking. Locale A was a wooded ritual area, marked with some pots placed upside down on the side or at the base of termite mounds. Local informants

reported that the pots had been placed there by local exorcists. They could tell this from both the context (termite mounds) and the upside-down position of the pots.

The local people believe that exorcists have some magical power to expel evil spirits and cover them with pots on anthills. And that the expelled spirits remain there as long as the pot is not overturned. But if anyone either knowingly or unknowingly overturns the pots that spirit will possess her or him.

Site Hvlk-30, Kirando. This was located in a wooded area about one kilometer northwest of site Hvlk-18 and 200 m from the Luafi river (Fig. 4.2). It was marked with some gourds placed at the bases of small anthills. The gourds were used for exorcism similar to the pots described at site Hvlk-4. The local healers said that pots were used in the past, but today they prefer gourds because they are "pure" and affordable--pure because they are not contaminated by cooking as pots are, and affordable because they do not require special skill to obtain them (as is the case with pots). Anyone can plant them or get them freely from a neighbor.

Site Hxlo-5, Kalundi. This site consisted of twelve malungu furnaces (ten of which were still standing) and two vintengwe. Each furnace was placed on a separate termitary. During the survey we found medicinal gourds in three malungu furnaces. One appeared to have been placed there during the previous night. It was sitting at the center of the furnace with a thin bark rope tied around its waist, and white foam was gently coming out of the mouth and wetting the lower side of

the gourd. We were cautioned by a village official, who was with us in the field, not to get closer or photograph it for what he insisted to be "hatari sana sana!!" (very, very dangerous!!). A local informant whom we interviewed in confidence given the sensitivity of the matter, said that such type of medicines were meant either for treating infertility or providing "advanced bodily immunity" ("zindiko") against evil intentions, especially witchcraft.

Societal Healing

Rituals at site Iall-3, Kala, were different from the three sites described above and was reported mainly along the lake shore, indicating that it was probable more commonly practiced there. Here the rituals involved killing "impure" members of the society for the purpose of purifying society and ensuring spiritual and bodily health of that society. This practice emanated from the belief explained in chapter 2 that problems (such as sickness, drought, famine etc.) experienced by the living people were caused by viswa. These were spirits of dead people who came back to avenge those who mistreated them when they were living. These spirits were believed to have specific ways of demonstrating their anger, including illness, accident, birth abnormality, drought, etc. Most often crop and animal sacrifices were satisfactory by themselves to reach some compromise with the angry viswa. When a problem, e.g., sickness, persisted it was believed that the spirit(s) responsible were not ready to compromise. The only solution

was to allow the spirits do what they wanted lest they punish the whole society.

The Fipa categorized some diseases as "incurable" and therefore caused by viswa. Such diseases included leprosy, small pox, and epilepsy. Other signs of persistent anger of viswa included breech birth and babies who started to grow teeth on the upper jaw. Anyone who happened to have any of these "problems" was taken to Kala island and left there to die by starvation and/or the sickness.

After we got this exciting account from the local people we visited the island to verify it. The island was small and rocky, measuring 90 meters in diameter and had little vegetation except a few small bushes. It took us about 15 minutes of rowing to reach it. Our investigation revealed a few human bones, including radii, scapulas, and hip-bones (some of which were collected). These were trapped in the hollows below the rocks and between rock boulders. There was no doubt that some bones had been washed away by water. The finds substantiated the information given by local people.

Microlithic Industry

The investigation revealed only one site (Ialm-5) that consisted of microlithic materials. The site was located along the Kausinze river valley, southeast of site Ialm-4 at King'ombe. The stone materials included micro-scrapers, burins, flakes,

cores, and chert boulders (raw materials). The presence of these boulders together with the ubiquity of refuse (flakes) suggested that the site had been used for tool production.

It was noted in chapter 4 that the site also revealed ironworking materials: three refining furnaces and heaps and scatters of slag. We opened three shovel tests, two on the northern side and one on the southern side of the river to determine the stratigraphic context of the cultural materials. One northern pit placed 12 m from the river bank and the one southern pit placed 5 m from the river bank revealed microlithic materials from the surface down to 60 cm below ground. The last pit, dug 2 m away from the river bank, did not yield any cultural material. Neither sherds nor metallurgical materials were recovered from the shovel tests. This is not surprising because the preservation quality of the vintengwe and slag suggested that the ironworking activity was contemporaneous with that at site Ialm-4. The later is dated by oral traditions to the 1920s.

Given the depth of the microlithic artifacts, we can rightly say that they are older than the relics of the iron technology, most likely predating the Iron Age.

CHAPTER 6

EVIDENCE FROM EXCAVATIONS

In chapters 4 and 5 we learned that site survey and ethnographic investigations yielded 75 sites that varied in cultural context from microlithic components to Iron Age settlements, ironworking, and ritual localities (Fig 4.1). We also noted in chapter 5 that both ethnographic and surface survey left several questions unanswered particularly those dealing with katukutu and Barongo-type iron technologies, as well as settlement sites. The questions concerned furnace dimensions, number and location of tuyere ports, and paucity of slag in katukutu sites; stratigraphic order of cultural materials found on the surface at habitation sites; and chronometric dates of both metallurgical and habitation sites.

This chapter presents material evidence from excavations which aim at solving these and other problems covered by excavation. Materials presented here were excavated from thirteen sites or 17% of 75 sites found in the research area. These were selected to integrate the range and variability of site types and geographical locations. Nine or 14% of the sixty-six ironworking sites were excavated: six (including HvIk-1, -17, -25, -32, -35 and -39) in Kirando; two (IaIm-1 and 4) in

King'ombe; and one (Hxlo-2) in Kalundi. In terms of technology, these were divided as follows: six (including Hvlk-1, -17, -25, -32 and Ialm-1) katukutu sites; four (Hvlk-39, Ialm-1, -4, and Hxlo-2) malungu sites; and one (Hvlk-35) Barongo-type site. Additionally, four or 20% of the twenty non-metallurgical sites were excavated, including Hvlk-11, -19, -26, and -58. The following is the description of each of the excavated sites and their findings. The sites are presented according to types.

Katukutu Sites

Six sites (12% of the 51 katukutu sites (Table 5.1)) were excavated according to the goals stated above. These sites were selected on the bases of geographical representation, ratio of sites per research locality, preservation quality of cultural materials and representation in terms of intra-technological variations such as decorated versus undecorated furnaces, wider versus narrower tuyeres (in reference to the bimodal characteristic of tuyeres explained in chapter 5), and single versus multiple layers of the furnace walls.

Five of the six sites were in Kirando, where 94% of the katukutu sites were found, and one was from King'ombe where 4% of the katukutu sites occurred. No site was excavated at Kala because of low occurrence (2) and poor preservation of the sites.

Hvlk-1, Kirando

The site is located on latitude 7° 20' 05" south and longitude 30° 39' 30 east along a grassy valley adjacent to a large granite boulder measuring 15X15X4 m. The site extends 30 m north-south (N-S) and east-west (E-W). The nearest water source is the Sokoso river, 300 m to the east. It is, however, possible that the valley next to the site had provided underground water for the smelters since a pit, which may be an old well, is located 150 m south of the site.

When it was recovered, the site consisted of eight low-shaft furnaces situated around a termitary (Fig. 6.1). One furnace was well preserved (Fig. 5.1), but the remaining seven had collapsed. Five furnaces were decorated with holes punched on the surface using a wooden stick (from the impressions left on the edges of the holes) about a centimeter wide. All of the furnaces had been buried by depositions following the abandonment of the site so that the complete shapes and heights of the furnaces could not be measured without excavating them. Two heaps of tuyeres were found, one to the south and the other to the north of the site (Fig. 6.1). Slag was very rare, only a few droplets were found.

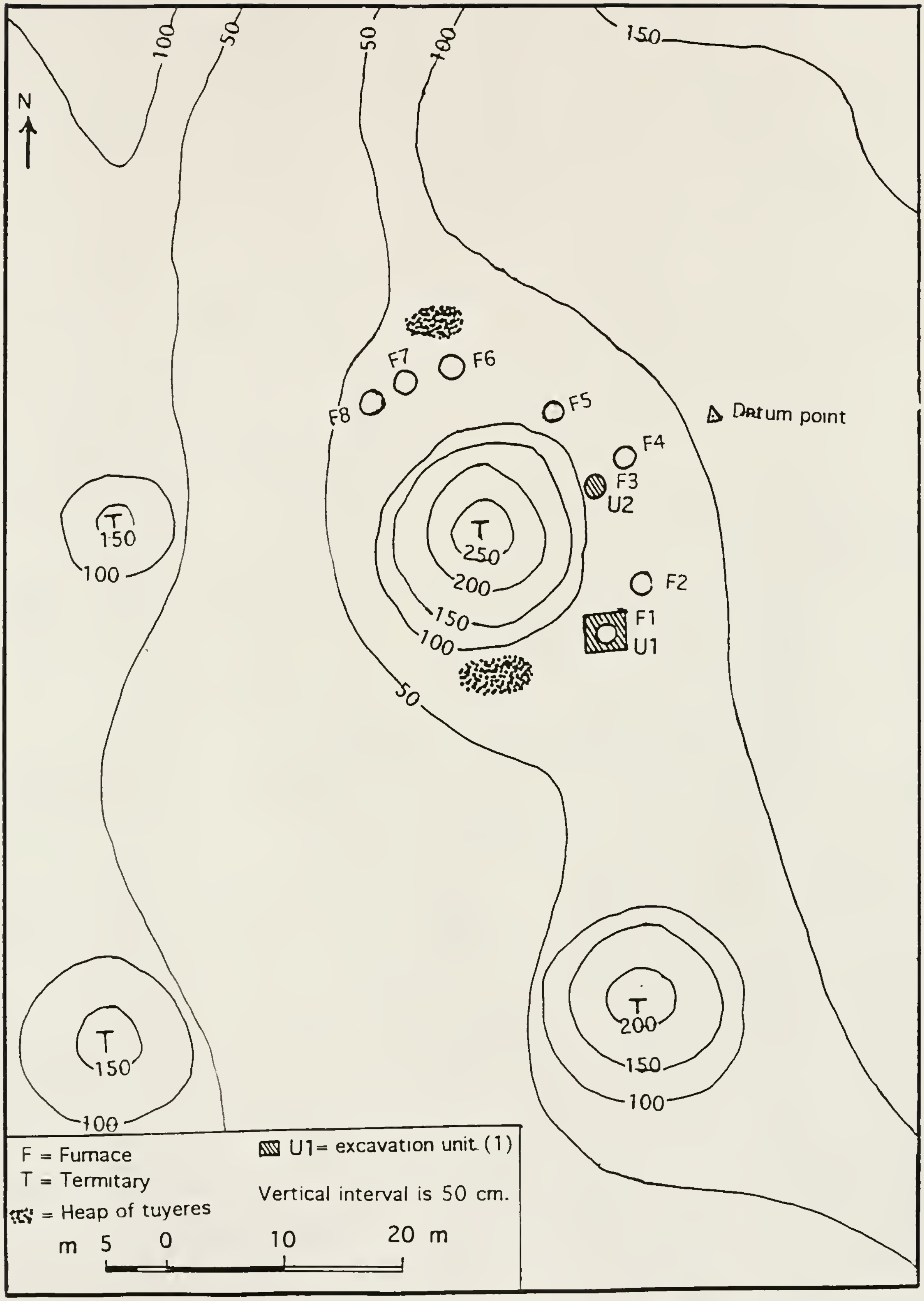


Fig. 6.1 Plan of site Hvlk-1, Kirando

The site was selected for excavation because of good furnace preservation including an intact one (Fig. 5.1). The site also had both decorated and plain furnaces making it convenient to examine the two styles at one place. This was the first site to be excavated and was done during the survey period. The reason for this early excavation was to obtain datable materials (especially charcoal) that could enlighten us about the temporal context of the cultural materials found in the research area.[1] Additionally, we wanted to expose the complete furnace, examine its dimensions, and tuyere ports. Both the chronology and the knowledge about katukutu furnaces, in turn, would assist us in setting strategies for intensive excavation when the time arrived (the third and fourth field seasons).

Two excavation units were opened at this site. Unit 1 encompassed the complete furnace (F1) and Unit 2 was opened in the interior of a fallen furnace (F3) (Fig. 6.1).

Unit 1 measured 300X300 cm, encompassing an area up to 120 cm around the furnace. This area was sub-divided into six blocks, each measuring 150X100 cm wide. Three and one half blocks were excavated, each down to 60 cm below datum. Table 6.1 provides numbers and weights of cultural materials unearthed from this Unit. It shows that the top 10 cm consisted mainly of pieces of tuyeres and furnace fragments. The next 40 cm (levels B through E) had a high concentration of cultural materials. The original ground level was found at 48 cm below

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[1] Two charcoal samples were submitted to Beta Analytic for radiocarbon dating in January 1993. Unfortunately the results did not arrive early enough to assist us in setting excavation strategies during the third and fourth field trips.

datum. The level between 50 and 60 cm was largely sterile, consisting of compact termite clay (Fig. 6.2).

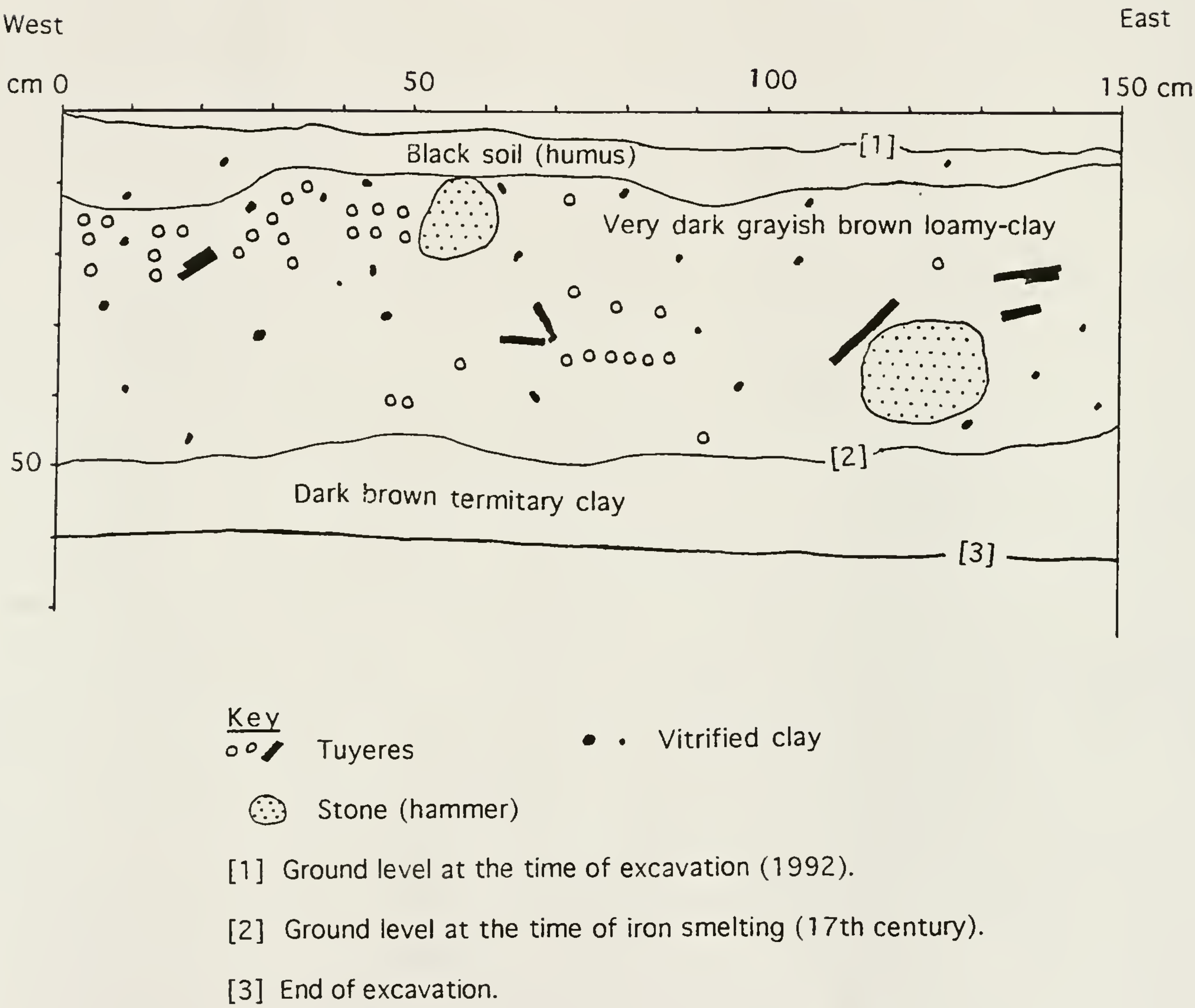

Fig. 6.2 Profile of the northern wall, Block 3, Unit 1, Site Hvlk-1.

Table 6.1: Materials Excavated from Outside Furnace F1, Unit 1, Site Hvlk-1

LEVEL	VOL.	Slag		Vitrified Clay		Iron Ore		Tuyere Pieces		Potsherds		Miscellan.	
cm	cm^3 '000	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)
A:10	530							12	1.69				
B:20	530	3	0.015	42	0.554			55	3.84	4	0.085		
C:30	530	67	0.257	58	0.367	2	0.011	134	13.16	9	0.046	ch 7 bn 1	0.012 0.004
D:40	530	14	0.064	18	0.185	2	0.032	145	14.00	13	0.106	ch 5	0.028
E:50	530	2	0.015	9	0.036			117	14.57	14	0.091	ch 1 bn 8	0.011 0.010
F:60	530			2	0.010	1	0.003						
Total	3180	86	0.351	131	1.152	5	0.046	463	47.26	40	0.428		

bn = bone and ch = charcoal

In addition to the materials shown in Table 6.1 the excavation revealed two quasi-spherical granite hammer stones, one in Block 1, measuring 14 cm in diameter and located between 15 and 30 cm below ground; and the second found in block 3 between 10 and 30 cm below datum, measuring 20 cm in diameter (Fig. 6.3 and 6.4). The rocks were pock-marked (had small circular dips on the surface) suggesting that they had been used as hammers, most likely for breaking slag from blooms.

We noted that the furnace was globular in shape (Fig. 6.3 and 6.4), measuring 110 cm in height and varying in external diameter from 80 cm at the base, 100 cm at the middle, 45 cm at the neck, and 40 cm at the rim. It consisted of two layers in the wall; the outer layer was plain (undecorated) and was, in essence, a large patch applied to the primary (inner) layer in order to reinforce it. The primary layer was decorated with

holes punched randomly on the surface using a wooden stick about a centimeter thick. The holes varied in depth from 0.5 to 2 cm and were spaced between 1 and 12 cm apart.

Fig. 6.3 Excavation at site Hvlk-1 showing ordinary tuyere ports and hammer stones

Eight openings were located at the original (pre-deposition) ground level. Seven of these were funnel-shaped (wider outside than inside) averaging 24 cm in width and 20 cm in height on the outside and 18 cm in width and 16 cm in height inside (Fig. 6.3. and 6.4). One port contained three tuyere pieces in situ.

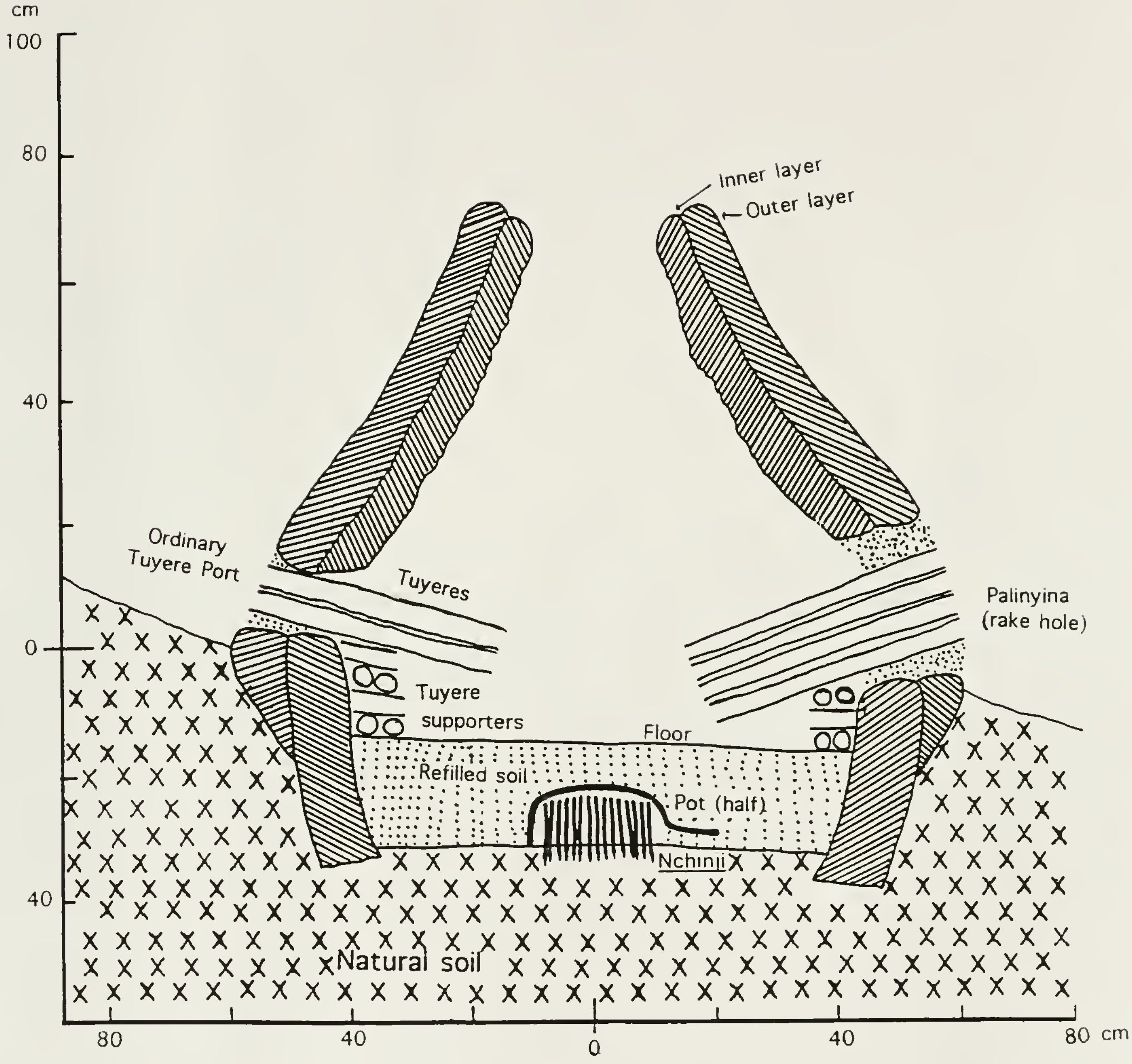

Fig. 6.4 A profile of a typical <u>katukutu</u> furnace.

The eighth opening was wider than the others, measuring 66 cm in width and 27 cm in height on the outside and 60 cm in width and 24 cm in height inside (Fig. 6.5). The Fipa smelters referred to the wider opening as "palinyina", meaning "maternal opening"--a name that emphasized reproduction symbolism, a central symbolic armature of indigenous African iron metallurgy. In this context the hole was equated to the birth canal rather than the simplistic function of extracting smelting products and refuse (see details in chapter 5). Given the ritualistic similarity between the two technologies (discussed below) I suspect that the wide port on the katukutu furnace served similar technological and symbolic functions as the palinyina in the malungu technology. For this reason this term, palinyina, is adopted for the katukutu technology.

Fig. 6.5 Palinyina, furnace F1, site Hvlk-1.

Tuyeres were the most abundant materials. They were small in size, varying in external diameter from 3.2 and 4.4 cm and in internal diameter from 2.0 to 3.6 cm. There were no complete tuyeres found, only tips and body parts. Slag largely constituted droplets or prills and a few acicular pieces.

The potsherds came from three pots: an undecorated small jar (14 cm projected rim diameter) with fine paste; a large globular pot (28 cm projected rim diameter) with coarse paste; and a carinated pot, burnished both inside and outside, and decorated at the rim with a continuous ring of cross hatches bounded by grooves. Sherds from the jar resembled the "central pot" collected from Unit 2. Almost all katukutu furnaces had a ritual pot (often a vertical half of jar) placed at their bottom centers, covering some medicinal herbs called vizimba (or kizimba sing.) in Kifipa. According to informants, the medicine was aimed at protecting the furnace and the entire smelting operation against evil intention and mishaps. It is therefore very likely that the jar-sherds found outside the furnace belonged to the second half of the "central pot" used in this furnace (F1). The other pots were probably used at the site for water storage or cooking. The bones were highly fragmented. Although it was possible to tell that the bones belonged to a medium-size mammal (goat/sheep or wild bovid), it was difficult to specify genera or species.

Furnace F3 of Unit 2 (Fig. 6.1) measured 110 cm in external diameter and 90 cm in internal diameter around the middle. It was decorated with uniformly punched holes on the

surface. The materials found from this Unit are summarized in Table 6.2. The top 30 cm below datum consisted mostly of pieces of furnace wall, vitrified clay, a few tuyeres and some slag. The levels between 30 and 50 cm exposed tuyere ports and yielded a significant amount of charcoal and charred wood in a matrix of ash. Both charcoal and charred wood were commonly located close to the wall and especially around tuyere ports. The next 20 cm below the tuyere ports (50-70 cm) yielded a large quantity of tuyere fragments and slag (mostly in the form of droplets) also in a matrix of ash. Charcoal and some pieces of charred wood were also found, especially along the furnace wall. We also uncovered a 2 cm-long piece of charred bone from a medium-size mammal. With this small sample it is hard to tell whether the bone was part of the smelters' food that was accidentally thrown into the furnace, or it was deliberately placed in the furnace as flux. The levels between 70 and 95 (K through Q) yielded a "central pot". The furnace floor was located at 82 cm below datum. Below this level, we encountered hard and compact natural soil.

The "central pot" was undecorated and consisted of only one vertical half. This was placed upside-down at the center of the furnace floor and was coated with a black, sticky clay perhaps meant to protect it from the weight of materials (ore, wood, charcoal, slag, and bloom) above it as well as high temperatures inside the furnace.

Fifteen thin (0.5-2 cm in diameter) charcoal and charred pieces of wood (or nchinji in Kifipa) were found beneath the pot,

hammered into the ground. The lower ends of the nchinji had been sharpened to facilitate their penetration into the ground. Some local people consulted about the possible meaning of this feature referred to it as kizimba (vizimba plur.). This is analogous to a kind of medicine (magical) used by the Fipa today for various ritualistic purposes, especially to protect houses, crops, fishnets, and other valuable properties against evil intentions.

According to former iron smelters from the plateau, vizimba were used in the malungu by ironworkers on the plateau to expel evil spirits and sorcerers, as well as "catalyze" the smelting process.[2] As one informant put it, "vizimba had miraculous powers (nguvu za maajabu); they pulled iron from the ores. Without vizimba you could not get bloom, only slag".[3] Although the kind of vizimba used in malungu were different from the one described above[4] (e.g., neither pot nor nchinji were applied in malungu as will be seen below) there is no doubt that the pot and the nchinji were used for ritualistic purposes similar to those applied by other iron workers in sub-Saharan Africa, including the Tumbuka of north-central Malawi (van der Merwe and Avery 1987); Tabwa of southeastern Zaire (Roberts 1993); and the Barongo of northwestern Tanzania (Schmidt in press).

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[2] Xavery Mwanakatwe, interview at Kalundi (1993).
[3] Ibd.
[4] The term "vizimba" is here applied generically without taking into consideration the specific ingredients which differed significantly not only between the malungu and the katukutu technologies but also within each of them.

Table 6.2: Materials Excavated Inside Furnace F3, Unit 2, Site Hvlk-1

LEVEL	VOL.	Slag		Vitrified Clay		Iron Ore		Tuyere Pieces		Potsherds		Miscellan.	
cm	cm^3 '000	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)
A:10	64												
B:20	64	1	0.001	10	0.048			8	0.034				
C&D: 30	64	4	0.008	8	0.030			18	0.106			ch 3	0.008
E&F: 40	60	2	0.003	12	0.045			19	0.100			wd6* wd 4 ss 3	0.042 0.003 0.015
G&H: 50	60	\		1	0.003			5	0.131			ch 2	0.003
I&J: 60	56	4	0.013	1	0.006	1	0.009	49	0.614			wd1*	0.022
K&L: 70	56	50	0.099	8	0.013			6	0.012	1	0.005	bn 1 ss 4	0.001 0.005
M&N: 80	50			6	0.004					4	0.004	ss 4	0.003
O&P: 90	50	1	0.004	1	0.006			4	0.043	89	0.885	nc 15	0.220
Q:95	50												
Total	574	62	0.128	47	0.155	1	0.009	109	1.040	94	0.894		

bn = bone (charred), ch = charcoal, nc = nchinji (vegetal), ss = silt stone, and wd = wood (charred).
Asterisks in all tables indicate samples that have been C-14 dated.

Two pieces of charred wood (used as fuel in the smelting) found inside furnace F3 (Unit 2) were dated. The first (lab. # Beta 71386) came from 38 cm below datum and dates to 280 $\pm$ 60 bp, ranging in calibrated[5] (calender) years from 1470-1950 AD and the second (lab. # Beta 71387) came from 53 cm below

[5] C13 adjusted age was used to calibrate all the C14 radiocarbon ages to calender years and are reported in this work in two sigma range (95% probability of accuracy).

datum and dates to 200 ± 80 bp, ranging in calibrated years from 1530-1950 A.D. (Table 6.22).

Hvlk-17, Kirando

Located on latitude 7°27'13" south and longitude 30°40'38" east, site Hvlk-17 consisted of five fallen furnaces, a scatter of tuyeres, some vitrified clay, and a termitary. It was situated 300 meters south of the Namanyere road and 200 m east of a waterhole east of Katongolo. It measured 28 m NS by 25 m EW. Four of the furnaces were decorated. The decorations on three furnaces were applied using a wooden stick (with a rough surface), whereas on one furnace a finger was used since nail marks were also found. The wood-pierced holes measured 1.7-3.0 cm in depth, 1.5-1.7 cm in diameter, and were spaced between 3.1-5.4 cm apart; the finger-pierced holes were comparatively shallow. They measured 0.3 cm in depth, 1.1 cm in diameter, and were spaced 1.3 cm apart. In either case decoration was applied above the tuyere-port level.

The site excavated in order to test the hypothesis that furnace decoration, which often was associated with large tuyeres, represented a different technology. Eighty percent of the furnaces were decorated and about 84% of tuyeres were relatively large (belonging to the high mode, 4.4 cm of external diameter noted in chapter 5).

Two excavation units were established at this site. Unit 1 measured 200X200 cm and was opened around a decorated furnace, F1. The area up to 45 cm outside the furnace (block #1)

was dug down to 40 cm, yielding only a few cultural materials including pieces of tuyeres, slag, pieces of iron ore, and some vitrified clay (Table 6.3a). Block 2 (the furnace interior), measuring 74 cm in diameter, was excavated down to 50 cm. Materials recovered from this block included slag, pieces of bloom, quartz and siltstone gravels, charcoal, tuyeres, and a 'central pot' (Fig. 6.6) covering nchinji (Table 6.3b) in a manner illustrated in Fig. 6.4 above.

Fig. 6.6 "Central pot" (a vertical half) from furnace F1, site Hvlk-17.

The "central pot" was undecorated and was placed between 37 and 41 cm below ground (Fig. 6.6). Unlike the pot in furnace F3 at site Hvlk-1 that was coated with black clay, the coating clay on this pot was mottled red lateritic soil with white

calcitic clay. We also observed that the pieces of pottery found outside the furnace (Table 6.3a) were similar in paste, temper, and form to the "central pot", indicating that the pot had been split at the site; one half used and the other half discarded.

Table 6.3a: Materials Excavated Outside Furnace F1, Unit 1, Site Hvlk-17

LEVEL	VOL.	Slag		Vitrified Clay		Iron Ore		Tuyere Pieces		Potsherds		Miscellan.	
cm	cm^3 '000	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)
A:20	624	10	0.032	6	0.066	1	0.008	9	0.615	8	0.076		
B:40	637	284	2.597	55	0.491	18	0.195	39	0.208	11	0.072	qz 17 ss 5	0.062 0.101
Total	1261	294	2.629	61	0.557	19	0.203	48	0.823	19	0.148		

Table 6.3b: Materials Excavated Inside Furnace F1, Unit 1, Site Hvlk-17

LEVEL	VOL.	Slag		Vitrified Clay		Iron Ore		Tuyere Pieces		Potsherds		Miscellan.	
cm	cm^3 '000	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)
A:20	86							14	0.058			qz 1	0.001
B:30	43	1	0.002	4	0.014			132	1.867			bl 1	0.002
C:40	38	25	0.189	1	0.038			58	0.672	2	0.008	ss 3 bl 15	0.023 0.211
D:50	38	21	0.247	3	0.062			127	2.228	26	0.627	ch 3 nc* 23 qz 3 ss 4	0.012 0.882 0.025 0.116
Total	205	47	0.438	8	0.114			331	4.825	28	0.635		

bl = bloom, ch = charcoal, nc = nchinji (vegetal), qz = quartz, and ss = silt stone.

The furnace had fallen and only the base (the portion from the tuyere-port level downward) remained. The wall consisted of two layers; the inner layer measured 7 cm in thickness and

the outer layer 9 cm in thickness. We observed 10 tuyere ports (narrow openings) measuring 10 cm in average diameter and one palinyina (wider opening) measuring 35 cm in diameter.

Two pieces of charred wood (nchinji) from Unit 1, 41 cm below ground, have been dated. The first (Lab # Beta 63011) dates to 430 ± 70 bp, calibrated at two sigma to 1402-1644 A.D. with an intercept at 1450 A.D. The second (Lab # Beta 63012) dates to 350 ± 70 bp, calibrated at two sigma to 1433-1953 A.D. with intercepts at 1516, 1591, and 1621 A.D. The variation in dates may reflect the age of the dated woods since the two pieces belonged to different species (judging from density and size of xylem fibers) they perhaps also differed in age at the time they were used.

The second unit, also measuring 200X200 cm, was opened around another decorated furnace, F2. The top part of the furnace had fallen and the remaining part ranged between 70-80 cm in internal diameter with a wall thickness of 11 cm. Both the outside and inside areas of the furnace were dug down to sterile levels at 40 cm below datum. However, at 30 cm below datum we hit the water table. The unit yielded furnace rubble, slag, partially reduced ore, pieces of bloom, tuyere pieces, and a "central pot" (Tables 6.4a and 6.4b). The "central pot" comprised a round piece of a pot base (Fig. 6.7) as opposed to a vertical half-pot as seen in most katukutu furnaces (e.g., Fig. 6.6). There were no cultural materials found underneath the pot. However, given the high water content of the soil, it is difficult to tell whether this was a technological (stylistic or ritualistic)

variation or that the vegetal materials (nchinji) had disintegrated through time.

Fig. 6.7 "Central pot" (pot base), furnace F2, site Hvlk-17.

Table 6.4a: Materials Excavated Outside Furnace F2, Unit 2, Site Hvlk-17

LEVEL	VOL.	Slag		Vitrified Clay		Iron Ore		Tuyere Pieces		Potsherds		Miscellan.	
cm	cm^3 '000	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)
A:20	555	1[illegible]	0.227	27	0.213	5	0.128	5	0.676			qz 1	0.017
B:40	555	1[illegible]	0.273	5	0.095	4	0.158	11	0.056			bl 8 ch 1 ss 6	0.166 0.002 0.069
Total	1110	[illegible]	0.500	32	0.308	9	0.286	16	0.732				

Table 6.4b: Materials Excavated Inside Furnace F2, Unit 2, Site Hvlk-17

LEVEL	VOL.	Slag		Vitrified Clay		Iron Ore		Tuyere Pieces		Potsherds		Miscellan.	
cm	cm^3 '000	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)
A:20	101												
B:30	50	4	0.070	6	0.185	13	0.257	3	0.051			bl 2 qz 1	0.049 0.018
C:40	50							2	0.011	5	0.371		
Total	201	4	0.070	6	0.185	13	0.257	5	0.062	5	0.371		

With the exception of the pot base (as opposed to vertical half-pot) found in unit 2, there was nothing unusual about this site. This led to the conclusion that furnace decoration and large tuyeres did not represent a separate technology but were stylistic variations of the same technology (katukutu). This conclusion was also supported by findings from sites Hvlk-25, Hvlk-32 and Ialm-1.

Hvlk-25, Kirando

Located on latitude 7°26'52" south and longitude 30°40'59" east site Hvlk-25 consisted of fourteen furnace remnants (the highest number of furnaces in any one location), one of which was almost complete (Fig. 5.2), as well as two heaps of tuyeres and vitrified clay (Fig. 6.8). The furnaces were scattered across a small grassy valley which very likely provided ground water to the smelters since we did not find any perennial source of water near the site.

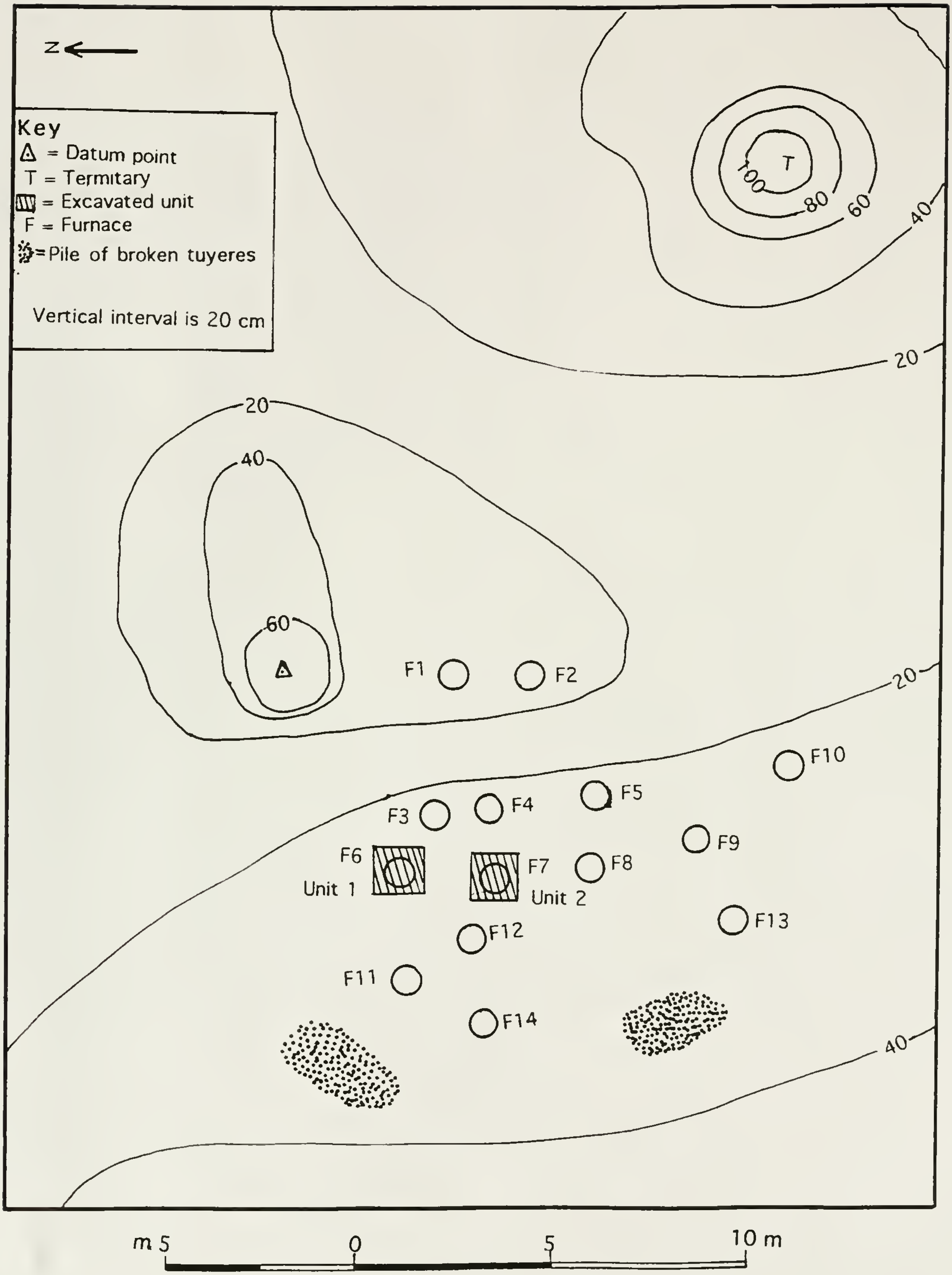

Fig. 6.8 Plan of sites Hvlk-25, Kirando

Three furnaces were decorated by the wood-punching technique, while the remaining were plain. Two furnaces contained three layers of walls, four furnaces had two layers of walls, five had a single wall and the remaining three were indistinguishable. The inner wall of one double-wall furnace was plain, while the outer one was decorated. The presence of layering indicates that the furnaces, similar to tuyeres and slag (for slag see chapter 7), were used repeatedly. The wall layers varied in thickness from 6-12 cm (measured around the middle of the furnaces). Usually the inner layer was thinner than the subsequent layer. Cleavage patching was also observed in three furnaces.

The furnaces were randomly scattered, not placed in a circular pattern as was often the case. Moreover, there was no termite mound within the site. The nearest termitary was located 30 meters from a furnace. It is, however, very unlikely that this was the source of clay for the fourteen furnaces, because it is relatively far away and young. It is likely that the termitary which provided the clay for these furnaces was located within the site and was exhausted through time.

The site was selected for excavation because the furnaces were well preserved and also we wanted to study the two sub-types of furnaces (decorated and plain) from one site.

Two excavation units were opened, each encompassing a furnace and measuring 200X200 cm. Unit 1 was opened around an undecorated furnace, F6. The region outside the furnace (Block 1) was excavated down to 70 cm, yielding some furnace

rubble, tuyere fragments, slag, vitrified clay, fragments of charcoal, and animal bones (Table 6.5a). The bones included a tibia, lumbar vertebra, and calcaneus of a rockhare (<u>Pronolagus lupestris</u>) and pieces of two shells of a genus of terrestrial tortoise (<u>Testudinidae</u>): a complete carapace (dorsal shell) of a juvenile and a complete plastron (ventral shell) of an adult. It seems likely that these animals may have been eaten by the iron smelters.

<u>Table 6.5a: Materials Excavated Outside Furnace F6, Unit 1, Site Hvlk-25</u>

LEVEL	VOL.	Slag		Vitrified Clay		Iron Ore		Tuyere Pieces		Potsherds		Miscellan.	
cm	cm^3 '000	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)
A:20	699	4	0.015	19	0.419			62	5.643				
B:40	643	16	0.064	66	0.313	1	0.004	232	23.27	3	0.046	ch 1*	0.008
C:60	574	20	0.140	85	0.387			285	36.29	40	0.728	bl 1 ch 3	0.015 0.010
D:70	267	6	0.191	14	0.069			23	0.318			bn 32 bl 3	0.029 0.178
Total	2183	46	0.410	184	1.188	1	0.004	602	65.52	43	0.774		

bl = bloom, bn = bone, ch = charcoal.

The furnace interior (Block 2) was excavated to level F (80 cm), yielding some furnace rubble, tuyere fragments, slag, vitrified clay, fragments of charcoal, a complete valve of a lacustrine bivalve (<u>Iridina spekii</u> of the <u>Mutelidae</u> family), and a "central pot" (Table 6.5b). It is known that some iron smelters used shells as a fluxing material (van der Merwe and Scully 1971), but I suspect that the valve found inside this furnace had a different function. It most likely had been used as a "table"

spoon by the smelters--a common function along the shore before the introduction of metal spoons. Several criteria suggest this: the valve was complete, it was not burnt, and was located on the top level where it may have been discarded when the furnace was abandoned.

Table 6.5b: Materials Excavated Inside Furnace F6, Unit 1, Site Hvlk-25

LEVEL	VOL.	Slag		Vitrified Clay		Iron Ore		Tuyere Pieces		Potsherds		Miscellan.	
cm	cm^3 '000	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)
A:20	25			14	0.119								
B:40	57	2	0.005	35	0.142			32	0.241			sh 1	0.009
C:50	38	2	0.010	54	0.186	1	0.010	77	0.734	1	0.020	bl 1 ch 1	0.006 0.005
D:60	50	6	0.036	15	0.034	1	0.022	14	0.118			bl 3 ch 3	0.030 0.008
E:70	64	3	0.013					10	0.232			bl 1 ch 1	0.008 0.004
F:80	57	2	0.008			3	0.011			1++	0.860		
Total	291	15	0.072	118	0.481	5	0.043	133	1.325	2	0.880		

++ A compete central pot.
bl = bloom, bn = bone, nc = nchinji (wood), and sh = shell (bivalve)

Two ritualistic differences were observed in this furnace. First, the "central pot" was different: it was complete (as opposed to a half), hemispherical bowl (as opposed to a globular jar) (Fig. 6.9) and was made from black clay similar to that used in its coating. Second, nchinji were not found under the pot. Since the furnace was located close to the middle of the valley, it is likely that the wet underground condition affected the vegetal materials (nchinji) in the same manner as observed at unit 2, site Hvlk-17 (although the water table was not

encountered at this site). The use of a complete, hemispherical bowl is probably a variation in belief.

Fig. 6.9 "Central pot", (hemispherical bowl) from furnace F6, site Hvlk-25.

The furnace was globular in shape, stood 110 cm high, and varied in internal diameter from 85 cm at the base to 90 cm at the middle and 20 cm at the rim. It consisted of two layers (Fig. 6.10) and eight openings: seven tuyere ports, averaging 18 cm in width and 16 cm in height, and one palinyina, with a width of 60 cm and a height of 45 cm. The wall consisted of two layers; the outer layer averaged 8 cm and the inner one was 12 cm in thickness.

Fig. 6.10 Furnace F6, site Hvlk-25, showing two wall layers.

Unit 2 was opened around a decorated furnace (F7) and was divided into two blocks: outside and inside the furnace. The exterior block (# 1) was excavated down to 40 cm and yielded furnace rubble, tuyeres, slag prills, vitrified clay, potsherds, and charcoal (Table 6.6a). The furnace interior (Block 2) was dug to level D (50 cm) and yielded some furnace rubble, tuyere fragments, slag, pieces of roasted ore (haematite), vitrified clay, a "central pot" (a half jar), and nchinji (Table 6.6b). Similar to site Hvlk-17, the potsherds found outside were of the other half of the "central pot".

Table 6.6a: Materials Excavated Outside Furnace F7, Unit 2, Site Hvlk-25

LEVEL	VOL.	Slag		Vitrified Clay		Iron Ore		Tuyere Pieces		Potsherds		Miscellan.	
cm	cm^3 '000	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)
A:20	643	67	0.652	109	0.823	5	0.058	119	8.080	9	0.065	bl 19 sd 3	0.131 0.019
B:40	655	240	1.857	51	0.297	30	0.296	61	3.938	21	0.809	bl 31 qz 1 ss 1	0.189 0.002 0.010
Total	1298	307	2.509	160	1.120	35	0.354	180	12.02	30	0.874		

Table 6.6b: Materials Excavated Inside Furnace F7, Unit 2, Site Hvlk-25

LEVEL	VOL.	Slag		Vitrified Clay		Iron Ore		Tuyere Pieces		Potsherds		Miscellan.	
cm	cm^3 '000	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)
A:20	96	12	0.124	2	0.013							ch 1	0.007
B:30	48	9	0.077	5	0.024			13	0.233	1	0.026	bl 4 ch 1	0.047 0.015
C:40	38	32	0.089	11	0.026			5	0.680	5	0.052	ch 3* ss 1	0.016 0.008
D:50	38	15	0.089	1	0.001	1	0.008	18	0.270	4	-??-	ch 1 nc 18	0.003 -??-
Total	220	68	0.379	19	0.064	1	0.008	36	1.183	10			

-??- = the weight is not known because the pot has been curated with its contents (nchinji and soil) intact.

The furnace measured 100 cm in external diameter at the tuyere-port level and the wall was 11 cm thick. It consisted of eight openings: seven narrow ones, averaging 15 cm in width and 12 cm in height and a palinyina, with a width of 30 cm, and a height of 20 cm. The base of the palinyina was 20 cm above the furnace floor whereas the bases of the narrow openings averaged 32 cm above the floor.

A charcoal sample from block #1, unit 1 and a charred wood sample from unit 2 have been dated. The former (lab. # Beta 63014) was excavated outside the furnace and dates to 100 ± 70, bp ranging in calibrated age from 1660-1955 A.D. and the latter (Lab. # Beta 63015) is a piece of nchinji from the furnace interior and it dates to 310 ± 60 bp with a range of calibrated age from 1448-1954 A.D. and an intercept at 1638 A.D. (Table 6.22).

Hvlk-32, Kirando

The site was located in a wooded area, 300 meters south of the Luafi bridge on latitude 7°28'18" south and longitude 30°43'59" east. It extended 43 m NS and 45 m EW and consisted of three fallen furnaces, a heap of tuyeres, some vitrified clay, and a few pieces of slag. These materials were found to the west of an old low and wide (4 m in diameter) termitary. One furnace was decorated while the others were plain. The nearest source of water was the Luafi river passing 150 m to the northeast. The site was excavated this site in order to learn more about non-decorated (plain) furnaces.

An excavation unit measuring 200X150 cm was dug around an undecorated furnace. The exterior area was excavated down to 80 cm uncovering tuyere pieces, slag, vitrified clay, and charcoal (Table 6.7a). The furnace interior was excavated down to 100 cm uncovering tuyere pieces, slag, vitrified clay, a "central pot" (a half jar covered with black clay), and nchinji (Table 6.7b). A piece of charred wood from the nchinji (lab #

Beta 64457) has been dated to 290 ± 80 bp, calibrated to 1640 A.D. (with a 2 sigma range of 1443-1954 A.D.) (Table 6.22).

Table 6.7a: Materials Excavated Outside Furnace F2, Unit 1, Site Hvlk-32

LEVEL	VOL.	Slag		Vitrified Clay		Iron Ore		Tuyere Pieces		Potsherds		Miscellan.	
cm	cm^3 '000	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)
A:20	684							3	0.420				
B:30	312	4	0.004			1	0.011	10	0.557				
C:40	294			2	0.010			12	0.782				
D:50	294			5	0.131			15	0.805	1	0.006		
E:60	294			2	0.017			29	1.477				
F:70	312	1	0.001	5	0.019			21	1.455				
G:80	328			2	0.002			12	0.524				
Total	2518	5	0.005	16	0.179	1	0.011	102	6.020	1	0.006		

Table 6.7b: Materials Excavated Inside Furnace F2, Unit 1, Site Hvlk-32

LEVEL	VOL.	Slag		Vitrified Clay		Iron Ore		Tuyere Pieces		Potsherds		Miscellan.	
cm	cm^3 '000	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)
A:20	39												
B:30	38												
C:40	50			1	0.003			3	0.030				
D:50	50			1	0.003			4	0.162				
E:60	50							10	0.281			wd 1	0.001
F:70	38			1	0.001			15	0.530			ch 1	0.001
G:80	28			1	0.001			6	0.283			ch 1	0.017
H:90	28	1	0.001	1	0.003			4	0.008	1	-??-	ch 1 ss 1 nc 12*	0.001 0.003 -??-
I:100	14			4	0.004			5	0.012			qz 1	0.001
Total	335	1	0.001	9	0.015			47	1.306	1			

The furnace was globular in shape and measured 98 cm in height and 80 cm in maximum internal diameter (measured at

the middle). It had seven tuyere ports measuring 24 cm in average diameter and one palinyina measuring 34 cm in width and 30 cm in height. The furnace wall comprised two layers: the outer layer measured 12 cm and the inner one 6 cm in thickness. The interior surface of the furnace was highly vitrified, consisting of drip bumps similar to those found in furnace F5, site Hvlk-17 (Fig. 5.3).

Ialm-1, King'ombe

The site is located on latitude 8°06'40" south and longitude 31°01'28" east, 10 km east of Kala, along the western border of a large terrace which encompasses King'ombe village located 4 km further west. It extends 500 m NS and 400 m EW. The Msakamanga river borders the site to the south and the Kala-King'ombe track crosses the middle of the site (Fig. 6.11).

The site consisted of six malungu each located on a separate termitary, nine vintengwe placed on 5 anthills, and seventeen katukutu located around six separate termitaries. The site was selected for excavation because of good preservation of the metallurgical materials. Because two technological types occurred at the site, it was hoped that we could learn more about their relationship. Additionally, two malungu were found to have been tempered with tuyere fragments and slag belonging to the katukutu type of technology (Fig. 5.8) as discussed in chapter 5.

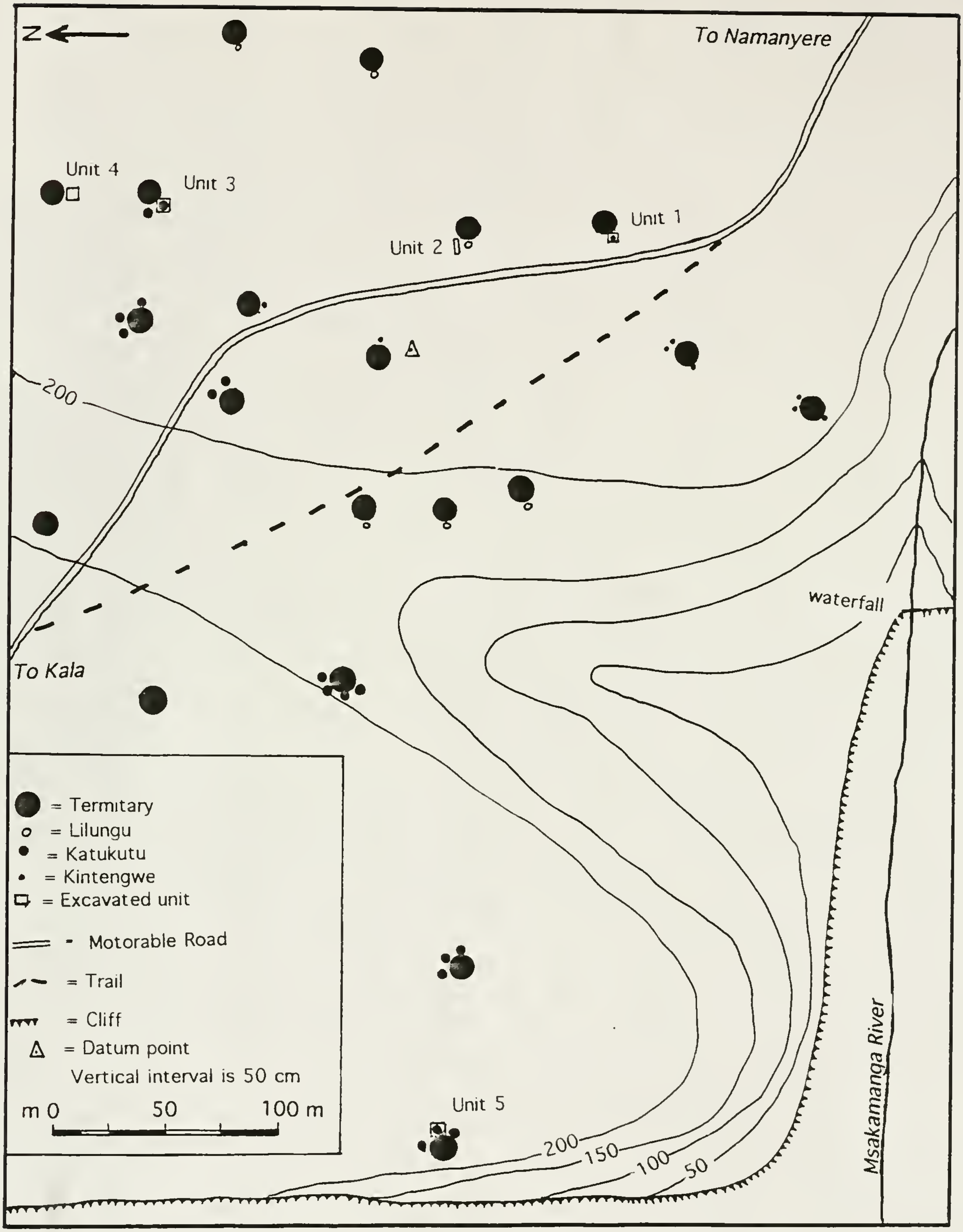

Fig. 6.11 Plan of site Ialm-1, King'ombe.

Five excavation units were established at this site (Fig. 6.11). The first unit was related to the malungu technology and is explained below under the malungu sub-section. Units 2 through 5 began as exploratory trenches, each measuring 300X100 cm, and were intended to locate katukutu furnaces otherwise difficult to pinpoint on the surface. This was because only two of the seventeen katukutu furnaces had visible structures on the ground surface (but both were engulfed by termite mounds making excavation difficult); the rest were marked only by furnace rubble. Units 2 and 4 failed to locate furnaces while units 3 and 5 were successful. The materials found are presented in Table 6.8.

Table 6.8 Katukutu Materials Excavated from Site Ialm-1.

UNIT	VOL.	Slag		Vitrified Clay		Iron Ore		Tuyere Pieces		Potsherds		Miscellan.	
cm	cm^3 '000	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)
2:50	400	53	0.656			15	0.335	3	0.880			ch 3	0.011
3:75	1247	102	2.583					143	14.27			ch 2*	0.009
4:50	750	2	0.187					1	0.132				
5:65	2502	41	1.085			5	0.126			1++	2.787	nc 20* mc 1 ch 3	-??- 1.169 0.066
Total	4899	198	4.511			20	0.461	147	15.28	1	2.787		

++ = A complete central pot (Fig. 6.12). * = source of a dated sample.
mc = mold clay; clay applied around the nchinji (between the furnace base and the rim of the 'central pot') to keep nchinji in place. It was made from the same clay as that of the 'central pot'.

The furnace in unit 3 was found 20 cm below datum. The unit was then confined to a 150X150 cm block around the furnace and was excavated to 75 cm below datum. We uncovered

furnace rubble, slag, charcoal, pieces of ore, and tuyeres (including a triple set in situ). The tuyeres protruded 30 cm inside the furnace and sloped down inwards between 15 and 20 degrees. Inside the furnaces, the tuyeres were supported by smaller pieces, 12-15 cm long, piled below each port. Neither a "central pot" nor nchinji was uncovered in this unit. The furnace measured 92 cm in internal diameter and the wall was 15 cm thick.

The furnace at unit 5 was uncovered at 30 cm below datum. The unit was realigned, measuring 200X150 cm to encompass the furnace. Excavation proceeded to 70 cm below datum, uncovering slag, iron ore (haematite), charcoal, a "central pot", and nchinji. The pot (a hemispherical bowl (Fig. 6.12)), was different from those found around Kirando: it was thicker, varying from 2.5-4.0 cm in thickness; it had a 1.5 cm perforation at the center (a round piece of charcoal was found stuck in the hole); and the interior side consisted of deep, up to 1.0 cm, nchinji impressions. These characteristics suggest that the pot was made inside the furnace by molding clay over and around the bundle of nchinji hammered in the ground. This is clear evidence that the pot was specially made for the purpose of ironworking rituals. We also noted that the furnace floor had been filled with some dark clay about 8 cm thick--the same clay used to make the "central pot". The furnace measured 95 cm in internal diameter (at the tuyere port level) and 14 cm in wall thickness.

Fig. 6.12 "Central pot", a hemispherical bowl (perforated at the center), unit 5, site Ialm-1, King'ombe.

Two samples, charcoal and charred wood, from this site have been dated. The charcoal (lab. # Beta 71392) excavated in unit 3 at 55 cm below datum dates to 360 $\pm$ 80 bp, with a calibrated age range of 1430-1950 A.D. The charred wood, a piece of <u>nchinji</u>, (lab. # Beta 71393) excavated in unit 5 at 60 cm below datum dates to 230 $\pm$ 50 bp, with a calibrated age range of 1650-1950 A.D. (Table 6.22).

Summary of Complementary Characteristics of the Katukutu Technology[6]

Furnace dimensions. Three of the nine excavated furnaces had at least one side complete from the base to the top. The furnaces were globular in shape, varying in height between 98 and 110 cm and in internal diameter from 65-80 cm at the base, 85-100 cm at the middle, 40-45 cm at the neck, and 20-40 cm at the rim. The walls varied in thickness between 12-16 cm at the middle and 6-8 cm thick at the rim.

Tuyere ports. The technology employed multiple tuyere ports. Eight or ten funnel-shaped openings (wider outside and narrow inside), one of which (palinyina) was larger than the others, were located at the original (pre-deposition) ground level of each furnace. We learned that soil deposition was caused by termites (Macrotermes falciger) dominant in the research area at a rate of 1 cm in 12.67 years or 0.8 mm per annum.[7]

The wider opening measured 40-66 cm in width and 18-27 cm in height on the outside and 35-60 cm in width and 16-24 cm in height inside. The remaining seven openings averaged 25 cm in width and 20 cm in height on the outside and 18 cm in width and 16 cm in height inside. Tuyeres were found in situ in two furnaces: unit 1, site Hvlk-1, and unit 3, site Ialm-3. In both cases, a set of three tuyeres was found per port and the

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[6] For additional characteristics see chapter 5.

[7] This is computed from the average age of the sites of 350 years BP and an average depth of 30 cm of deposition.

tuyeres were found to be placed at an angle sloping towards the interior in the second case.

Slag and bloom. Only small pieces of slag (including droplets or prills and needles) were found. Most of these were rich in iron (tested in the field by magnetic compass). Pieces of bloom were also found in several sites; they weighed up to 190 gm.

Charcoal and ash. There was very little charcoal recovered from the katukutu sites. Ash, on the other hand was found in all furnaces except those that were in wet ground. The scarcity of charcoal seems to be related with the paucity of slag. Since there was very little slag formed in the katukutu furnaces the charcoal could freely burn to ash without interference. A few species of charcoal were identified with the help of local experts (charcoal burners, local healers, hunters and former smelters). These included Mbanga (Pericopsis angolensis), Mngongoma (Afzelia quanzensis), Msangu (Acacia albida), Mfundwa, and Mgwina.

Rituals. All except one of the nine furnaces that were excavated had a "central pot" and all except two of the eight "central pots" had nchinji underneath. The pots, all of which were undecorated, varied in shape from hemispherical bowls to globular jars. They were coated with a black, sticky clay whose symbolic meaning is not known. Technologically, the clay perhaps meant to protect it from the weight of materials (ore, wood, charcoal, slag, and bloom) above it as well as high temperatures inside the furnace. A few species of charcoal

were identified with the help of local experts, including Mbanga (Pericopsis angolensis), Msondoka (Xerompis obovata), and Cheyu (Vellozia sp.).

Radiocarbon dating. Katukutu sites range in age from 400-200 bp, calibrated to mid-fifteenth to mid-eighteenth centuries A.D. (Table. 6.22)

Malungu Sites

Four sites (25% of the 12 malungu sites (Table 5.1)) were excavated. The criteria for site selection were similar to those used for katukutu technology, that is geographical representation, ratio of sites per research locality, and preservation quality. Of the four sites, one (Hvlk-39) was located in Kirando along the lake shore region; two (Ialm-1 and Ialm-4) were located in King'ombe on the escarpment; and one (Hxlo-2) located in Kalundi on the plateau. No site was excavated in Kala village because the only site that was well-preserved there was the demonstration site (Iall-1) which could not give us the original information we needed.

Site Hvlk-39, Kirando

The site is located on latitude 7°22'37" south and longitude 30°38'38" east, three kilometers east of Kirando port and 200 meters south of the Kirando-Mpata track. During the survey we found a fallen furnace located on the western side

(273°) of a termite mound surrounded with a scatter of slag and tuyere fragments. The pieces of slag were massive and dense, including tuyere-molded pieces (slag that solidified inside tuyeres). The furnace was buried to above tuyere port level (similar to katukutu furnaces along the shore). We also found a well 10 m south of the furnace. It is very likely that this well which is today used by herders as a source of water for their cattle was used by the iron-workers since there is no other source of water nearby.

The site was selected for excavation because of its uniqueness (the only furnace of the malungu technology around Kirando). We also wanted to verify the oral histories and testimonies that there was a significant influx of migrants along the lake shore from the plateau by the second half of the nineteenth century and these immigrants experimented with malungu technology along the shore (Manyesha 1988). If this was true we expected to find that not only the technology would be similar to that on the plateau but also the dates of this site would relate to the accounts. Thus, the excavation was also aimed at finding charcoal for radiocarbon dating.

A 300X300 cm excavation unit was established around the furnace. The unit was subdivided into five blocks, two of which were excavated. The first, located on the southeastern side of the furnace, was dug down to level E, 60 cm below datum. It yielded large amounts of slag and pieces of iron ore, as well as some tuyere fragments and charcoal (Table 6.9a). Most of these materials came from in front of the palinyina.

Block 2, the furnace interior, which averaged 120 m in diameter, was excavated down to the base at 85 cm below datum. Fragments of furnace walls, slag, partially reduced ore, tuyere fragments, charcoal and charred pieces of rectangular wooden strips (vizimba) were found (Table 6.9b). The wooden strips measured 10-25 cm long, 5-12 cm wide, and 0.5-1.2 cm thick, doubtlessly prepared for ritualistic rather than fuel-selected purposes. These were arranged in three levels below 76 cm below datum in a form illustrated in figure 6.5. This was a phenomenon characteristic of the malungu furnaces (Fig. 6.13, see also sites lalm-4 and Hxlo-2 below).

The furnace consisted of 9 tuyere ports and one palinyina. The palinyina measured 55 cm in height and 50 cm in width, whereas the tuyere ports averaged 19 cm in width and 30 cm in height. Additionally, the furnace consisted of two "construction courses" similar to those described in site Iall-1, chapter 5 (Fig. 5.7). The furnace seems to have comprised five courses when it was complete (at about 2.3 m). The estimation is based on the two remaining courses and the amount of furnace fragments found on the surface. The interior surface of the furnace was reduced; it had a dark brown color and was not vitrified like katukutu furnaces. The slag was dense and massive (mainly types A and a few B) and the tuyeres were wider than those found in most sites. They measured 6.8 cm in external diameter and some were clogged with slag similar to what was observed in other malungu furnaces in King'ombe and Kalundi.

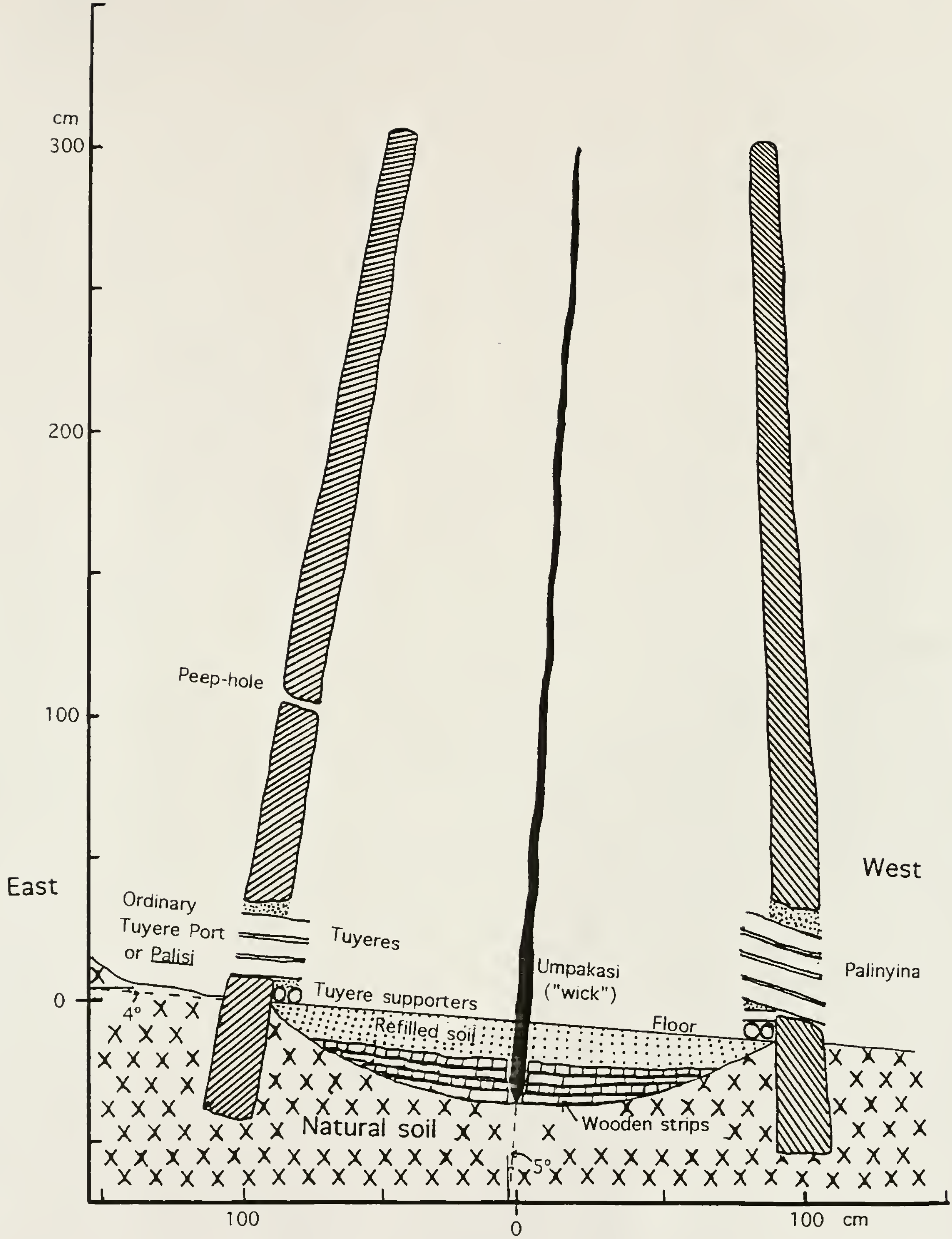

Fig. 6.13 A profile of a typical <u>lilungu</u>

Table 6.9a: Materials Excavated Outside Furnace F1, Unit 1, Site Hvlk-39

LEVEL	VOL.	Slag		Vitrified Clay		Iron Ore		Tuyere Pieces		Potsherds		Miscellan.	
cm	cm^3 '000	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)
A:20	369	3	0.136					1	0.135				
B:30	184	16	0.532					11	1.928			ch 1	0.010
C:40	184	41	1.903			28	0.689	11	0.859				
D:50	184	446	1.495			16	0.182	15	0.360			ch 1	0.009
E:60	184					2	0.006						
Total	1105	506	4.066			46	0.877	38	3.282				

Table 6.9b: Materials Excavated Inside Furnace F1, Unit 1, Site Hvlk-39

LEVEL	VOL.	Slag		Vitrified Clay		Iron Ore		Tuyere Pieces		Potsherds		Miscellan.	
cm	cm^3 '000	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)
A:10	113												
B:20	113												
C:30	113												
D:40	113												
E:50	113												
F:60	113	111	1.296			17	0.347	8	1.064				
G:70	113	361	3.131			127	3.290	20	1.264			ch 3	0.018
H:80	113	147	0.521									wd 2 *	0.108
I:85	57											wd 39	5.497
Total	961	619	4.948			144	3.637	28	2.328				

One date is available from this site (Beta-71389). It comes from a piece of the wooded strips, and dates to 30 ± 50, calibrated to 1890-1920 A.D (Table 6.22). This date conforms with oral tradition and histories that the site was one of the trial smelts conducted by immigrants from the plateau by the end of the last century as noted in chapters 2 and 5 above.

Ialm-1, King'ombe

The site consisted of relics of both malungu and katukutu technologies and the background information is provided under "Katukutu" sub-division above. Five excavation units were established at this site (Fig. 6.11), one of which (Unit #1) related to the malungu technology (the remaining four dealt with katukutu technology and have been described above). Unit one encompassed a refining furnace (kintengwe) (Fig. 6.14). The unit measured 100X100 cm and was excavated down to 30 cm yielding 138 pieces of flow slag (type B-n) weighing 1.5 kg three fragments of charcoal weighing 0.003 kg.

Fig. 6.14 Excavated kintengwe (refining furnace), site Ialm-1

Ialm-4, King'ombe

Located southeast of King'ombe village on latitude 8°07'35" south and longitude 31°03'20" east, site Ialm-4 contained two malungu and four vintengwe. The malungu were placed 300 m apart and each was found on the west side of a termitary. The vintengwe were located around one anthill, 400 m west of the nearest lilungu (furnace # F2). The site was crossed by a small brook, a tributary of the Kausinze river.

Good preservation of the site and the fact that it did not have evidence of katukutu technology attracted us to excavate there. We wanted to examine the furnace interior and learn about variation or consistency of the ritual evidenced at the bottom center of the furnaces.

Only one excavation unit was opened at this site and it included a furnace interior measuring 174 cm in diameter. The unit was excavated down to floor, 80 cm below datum, and yielded furnace rubble, slag, partially reduced ore, tuyere fragments, charcoal, and charred wood (vizimba) (Table 6.10). The unit also revealed a base of another lilungu, partially encircled by the one visible on the surface (Fig. 6.15). The two furnaces varied slightly in size; the primary (inner) furnace measured 199 cm in external diameter and the secondary (outer) furnace was 204 cm wide. The two furnaces were not concentric; they intersected in such a way that on the western side, around the location of the palinyina, the secondary furnace was built almost on top of the primary one. On the eastern side, however, the furnaces were spaced about 3 cm apart (Fig. 6.15).

This was perhaps done purposefully to facilitate the extraction of slag and other materials through the palinyina.

Fipa oral traditions maintain that smelters sometimes relocated malungu exactly on old sites for the purpose of reusing the old vizimba. It should be noted that although vizimba were believed to have infinite power, they were difficult to find. Relocation of furnaces occurred only where the previous furnaces proved to be highly productive, a quality which, for the Fipa smelters, was attributed primarily to vizimba. This was confirmed by the fact that the two furnaces had only one center (consisting the rectangular strips of wood) which corresponded to the inner (older) furnace and not the outer (younger) one.

Table 6.10: Materials Excavated from Site Ialm-4.

LEVEL	VOL.	Slag		Vitrified Clay		Iron Ore		Tuyere Pieces		Potsherds		Miscellan.	
cm	cm^3 '000	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)
A:20	476	10	0.180					1	0.004				
B:30	238	489	2.413					3	0.011				
C:40	238	813	2.305			2	0.015	14	0.441			ch 3*	0.033
D:50	238	1120	3.313	3	0.030	4	0.065	27	0.506				
E:60	238	402	1.009			2	0.012	13	0.399				
F:70	238	41	0.660	1	0.004			4	0.009			wd 32	0.427
G:80	238											wd 9	0.126
Total	1904	2875	9.880	4	0.034	8	0.092	62	1.370				

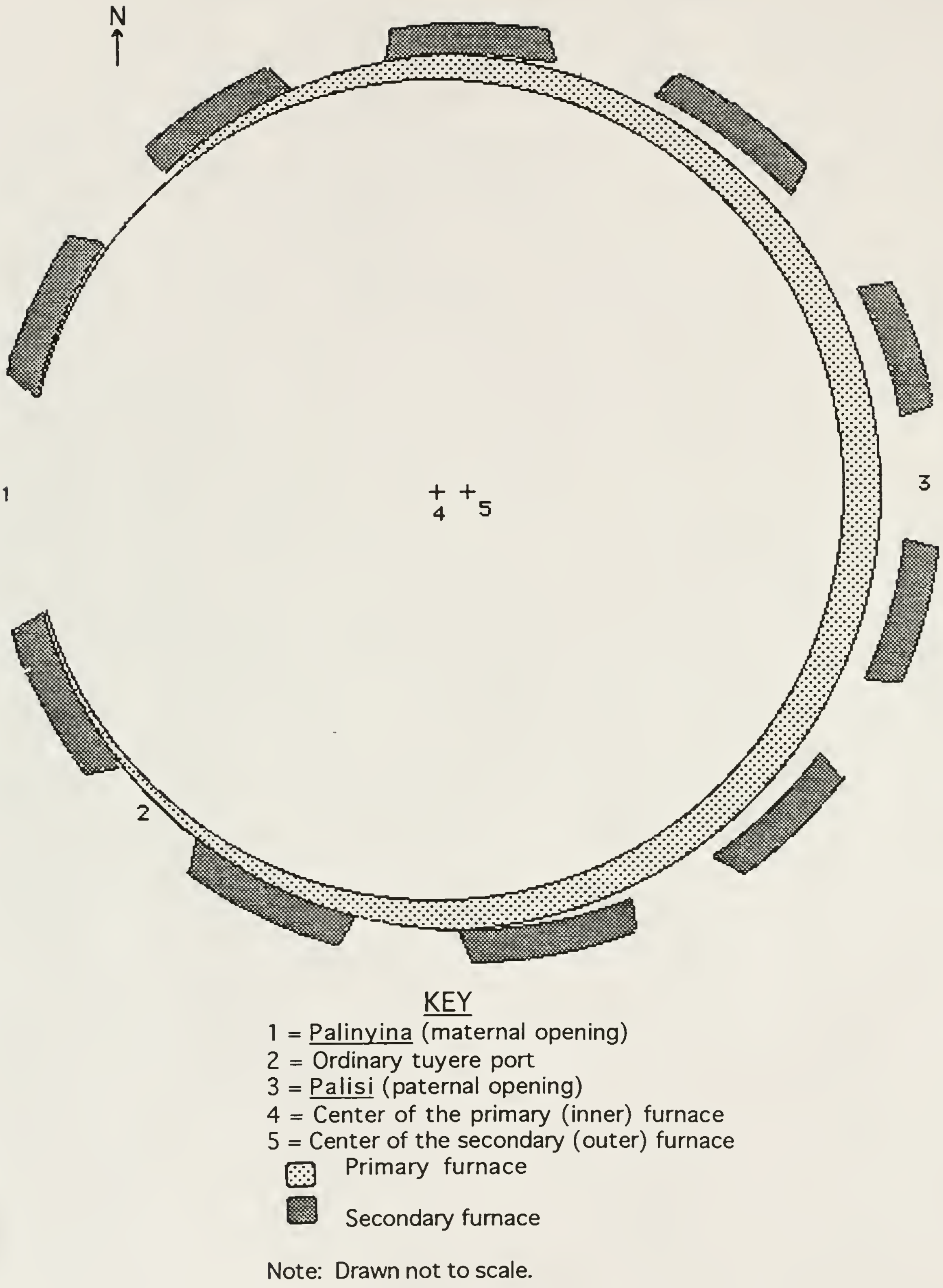

Fig. 6.15 A new furnace built around an old one, site Ialm-4.

One piece of charred wood (kizimba) has been dated (Beta 71394) to 101.0+ 0.6%[8] (a post-AD 1950 date). This date is questionable because, according to local informants, iron production at this site and others around King'ombe ceased in the 1920s. Iron production ceased a decade earlier than on the plateau because from the beginning of the century King'ombe began receiving imported iron from Kala, the nearby port.

It was noted in chapter 4 that this site, together with Hvlk-39 and Hxlo-2, were used to estimate the number of tuyeres in a cubic meter of smelting refuse in order to find the minimum frequency of furnace use. The site had a refuse heap of 0.5 cubic meter which yielded 117 complete tuyeres. The furnace had nine ordinary ports, each of which housed three tuyeres and the palinyina which accommodated six tuyeres. This means that 33 tuyeres were used per smelt. Therefore, with 117 total number of tuyeres the site must had been used at least four times (i.e., 117 ÷ 33) before it was abandoned.

Hxlo-2, Kalundi

Located on latitude 7°53'20" and longitude 31°21'48" and extending 200X200 m, site Hxlo-2 had three malungu (one of which has fallen). All furnaces were located on the western side of a termitary and a borrow pit was located on the northern

[8] The date was reported by the Beta Analytic Inc. as a percentage of the modern standard. The measured sample activity was found to be indistinguishable from the modern reference standard. Old samples result in a percentage value less than 100% which is then converted to an age equivalent (e.g. 50% of modern means 5570 BP, 1 half-life). The C14 content from this sample suggests an age of post AD 1950.

side of each furnace. To the west of each furnace there was a heap of tuyere and slag averaging 3 m in basal diameter and 1.5 m high.

One of our key informants, Xavery Mwanakatwe (appendix A) worked at this site in the 1930s. We selected this site for excavation in order to cross-examine the reliability of the oral accounts. This site was also used for testing the furnace-use frequency formula we devised. Mwanakatwe said that the furnace was used for three years, 1932-4, and he remembered that 6-8 smelts were conducted per season per furnace.

The furnace had produced two cubic meters of refuse which revealed 815 complete tuyeres, each averaging 0.85 kg (based only on tuyeres that were free from slag coating and clogging). The furnace had nine ordinary ports, each of which housed four tuyeres, and the palinyina which housed eight tuyeres. This means that 44 tuyeres were used per smelt. Therefore, with 815 total number of tuyeres the site must had been used about nineteen times (i.e., 815 ÷ 44) before it was abandoned. Therefore, our finding was not far from Mwanakatwe's estimate of 6-8 smelts per season.

Excavation was confined in the interior of the furnace (F1) which measured 207 cm in internal diameter. A 200X100 cm trench was excavated 40 cm deep and yielded slag, tuyere pieces, charcoal, and charred pieces of rectangular wooden strips (vizimba) (Table 6.11). The wooden strips, measuring 20-28 cm long, 5-10 cm wide, and 0.3-0.8 cm thick, were piled in four courses as shown in figure 6.5. Aside from the rectangular

strips, we found broken charcoal of what had been a long and thin wooden stick. The recovered pieces added up to 36 cm in length and ranged between 1.5 and 1.8 cm in diameter. According to a former smelter, who had worked in another furnace at this site in the 1930s, the stick was part of a "furnace wick". He said that each furnace had a long stick running through its central axis and was used "as a wick, bringing to the furnace base, fire lit at the top of the furnace at the beginning of the smelting process".[9] Mwanakatwe also elaborated that this stick was viewed as a magical conductor, transporting magical powers from the vizimba at the furnace bottom to the top, safeguarding the combustion process during smelting.

Table 6.11: Materials Excavated Inside Furnace F1, Unit 1, Site Hxlo-2

LEVEL	VOL.	Slag		Vitrified Clay		Iron Ore		Tuyere Pieces		Potsherds		Miscellan.	
cm	cm^3 '000	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)
A:10	200	351	2.926			1	0.015	11	0.199				
B:20	200	1278	3.308	9	0.007	1	0.003	12	0.086			ch 2	0.015
C:30	200	131	0.600	2	0.002	13	0.178	3	0.127			ch 1 wd 80*	0.006 0.225
D:40	200	19	0.085			1	0.002					wd 49	0.080
Total	800	1779	6.919	11	0.009	16	0.198	26	0.412				

The furnace has been dated to 60 ± 50 BP (Lab. # Beta 63018). This is calibrated to A.D. 1683-1955 (Table 6.22). The

[9] Xavery Mwanakatwe, interview at Kalundi (1993).

date plus other evidence from the excavation conform, to a large extend, with the information given by informants.

Summary of Complementary Characteristics of the Malungu Technology[10]

Charcoal and ash. There was more charcoal recovered from the malungu sites than in katukutu sites. Most of the charcoal had been scooped out of the furnace and was found in the refuse heaps. Charcoal entrapments in the type B-m slag was very common. The smelters of malungu technology used a much wider range of trees compared with the katukutu technology. Some pieces of charcoal were taken to local experts for identification. The following trees were recognized: Mbula (Parinari curatellifolia), Msuku (Uapaca kirkiana), Msumbu (Brachystegia manga), Mninga (Pterocarpus angolensis), Mtumbe, Kulungu, Mwenge, Kalunguti, Mtembo, and Chikali.

Rituals. Rectangular wooden strips were used for ritual purposes at the center of the furnaces in the malungu technology (as opposed to pot and nchinji used in the katukutu technology). In addition to the strips the malungu smelters used a "magical" wick which transmitted power from the bottom to the rest of the furnace. I suspect that the perforation found on the "central pot" recovered from unit 5, site lalm-1 (katukutu furnace), probably had a similar function. Unfortunately, the local experts failed to identify the trees used as "furnace wick". It seems that the shrub used for this purpose was not a common

[10] For additional characteristics see chapter 5.

one. The trees used to prepare the rectangular strips were the same as those used for charcoal.

Radiocarbon dating. The technology post-dates the katukutu technology. It ranges in age from the late nineteenth century to the mid-twentieth century A.D. (Table 6:22).

Barongo-type Site

One site (33% of the 3 Barongo-type sites (Table 5.1)) was excavated. The selected site, Hvlk-35, had more materials (furnace slabs, slag, and tuyere fragments) on the surface than the other two. The site was situated on the slope of a ridge overlooking the Luafi river 100 meters to the south, on latitude 7°27'29" south and longitude 30°44'19" east.

There were no clear signs of furnaces found on the surface. Therefore a 10X10 m area was scanned with a metal detector and 30 auger tests were dug in order to identify areas with high concentrations of metallic materials (e.g., iron ore, metallic slag, and metal tools) as well as to determine possible locations of furnaces. Eight spots were detected and three shovel-tests (50X50 cm) and three excavation units (two measuring 150X100 cm and one measuring 200X125 cm) were opened based on these results.

Two shovel tests dug next to each other in the middle of the site revealed a concentration of furnace rubble (termitary slabs) and three granite blocks, measuring up to 40X26X20 cm in

volume. No other artifacts were found and the soil beneath the rubble did not seem to have been thermally altered (e.g. reduced or oxidized) suggesting that the materials were in a secondary context. The excavation units yielded slag (most of which had charcoal entrapments or impressions), tuyeres fragments, potsherds, a piece of bone (bovid), and a piece of iron hoe (Tables 6.12; 6.13; and 6.14). Most of the slag with charcoal entrapment or impressions were found in unit 2 mixed with ash and charcoal fragments, seemingly scooped from a furnace. The remaining materials included furnace rubble, tuyeres, and potsherds that were similar to those found on the surface (described in chapter 5).

Table 6.12: Materials Excavated from Unit 1, Site Hvlk-35.

LEVEL	VOL.	Slag		Vitrified Clay		Iron Ore		Tuyere Pieces		Potsherds		Miscellan.	
cm	cm^3 '000	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)
A:10	150							4	0.104			mt 1	0.004
B:20	150	4	0.009					4	0.058				
C:30	150	4	0.006									ch 1	0.010
Total	450	8	0.015					8	0.162				

Table 6.13: Materials Excavated from Unit 2, Site Hvlk-35.

LEVEL	VOL.	Slag		Vitrified Clay		Iron Ore		Tuyere Pieces		Potsherds		Miscellan.	
cm	cm^3 '000	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)
A:10	250	341	3.005					48	0.898	16	0.187		
B:20	250	83	0.335					3	0.024	5	0.034	bn 1 ch 22*	0.004 0.138
C:30	250	4	0.017							2	0.014		
Total	750	428	3.357					51	0.922	25	0.235		

Table 6.14: Materials Excavated from Unit 3, Site Hvlk-35.

LEVEL	VOL.	Slag		Vitrified Clay		Iron Ore		Tuyere Pieces		Potsherds		Miscellan.	
cm	cm^3 '000	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)
A:10	150	57	0.490	10	0.060			10	0.094	4	0.050		
B:20	150	3	0.008									ch 1	0.002
C:30	150												
Total	450	60	0.498	10	0.060			10	0.094	4	0.050		

The technology practiced at this site (as well as at Hvlk-36, and 60) differed from both the katukutu and the malungu types in several ways. First, the site was not located in association with a termitary; second, the furnace was made of termite slabs as opposed to kneaded termitary soil; and third, the slag was dense and massive (close to the malungu slag) as opposed to light, porous, droplets of the katukutu technology. This technology is related to the one practiced by the Barongo people, northwestern Tanzania (Schmidt in press), explained in chapter 3.

Charcoal from unit 2 (Lab # Beta 63017) has been dated to 20 $\pm$ 50 BP, calibrated to A.D. 1702-1955. Elders of Masolo village, the closest village to the site (one km away), report that they have not witnessed ironworking in the area during their life time (meaning as far back as the 1920s), suggesting that the site was used earlier than that, perhaps in the nineteenth century.

Habitation Sites

A total of four sites or (31% of the 13 habitation sites (Table 5.1)) were excavated in accordance with the goals stated at the beginning of this chapter. These sites were selected on the bases of the amount of materials found on the surface, their relative age, and variability.

Hvlk-11, Kirando

Site Hvlk-11 is located 7°25'18" latitude south, 30°36'05" longitude east on a gentle hill slope separated from Lake Tanganyika by a 700 meter-wide impenetrable lacustrine marsh (inhabited by hippos) (Fig. 6.16). Potsherds varying in decorative motifs, vessel forms, paste, and age (from the Early Iron Age to the present), as well as daub and animal bones (hippo, buffalo, and cow) were found scattered in some cassava farms. A large termitary with scatters of tuyere fragments, slag, and furnace walls around it were found in the center of the site. Though none of the cultural materials were in situ, there is no doubt that they belong to a smelting site which must had been located around the termitary (since there is no other anthill nearby).

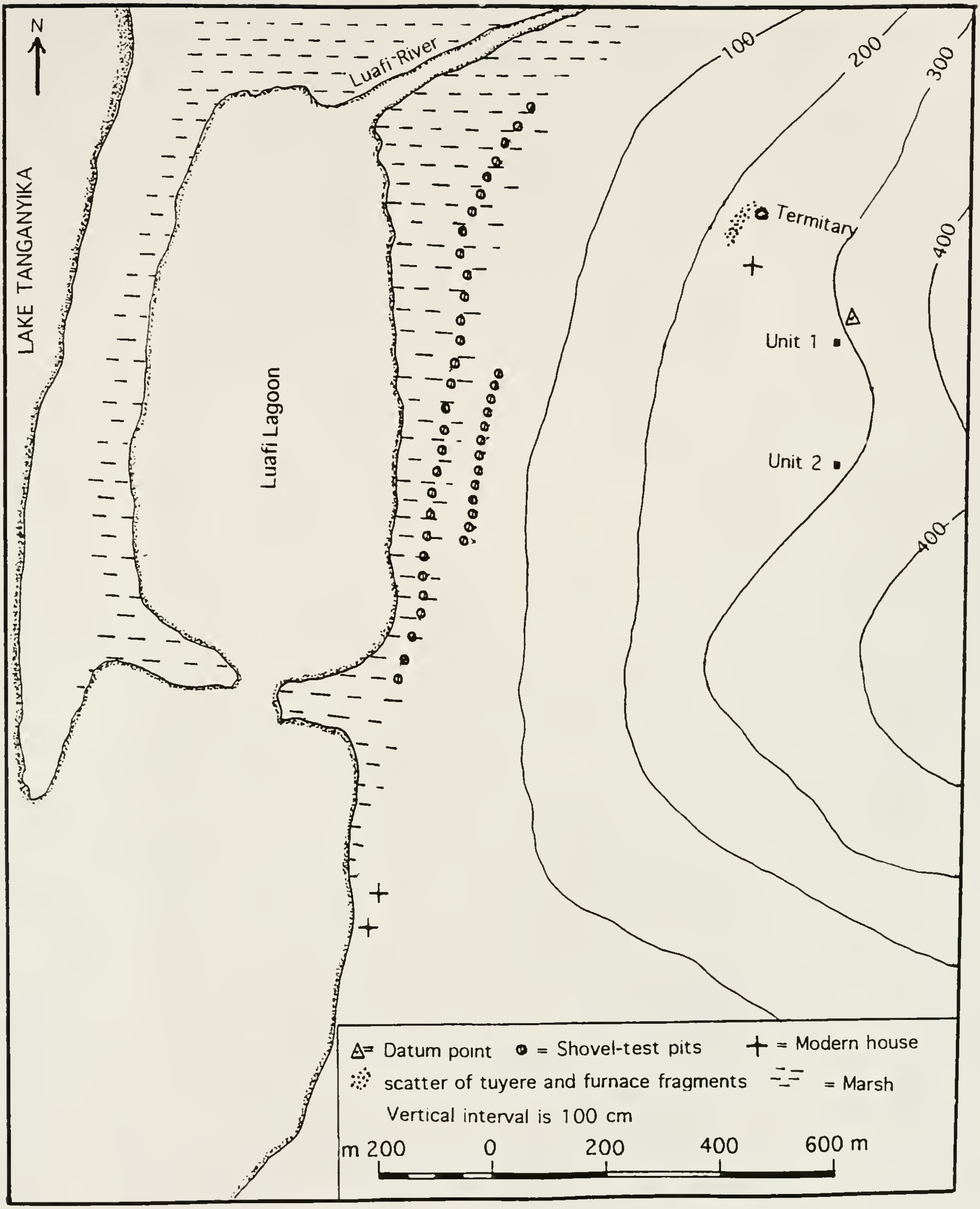

Fig. 6.16 Plan of site Hvlk-11, Kirando

Attracted by the density of cultural materials on the surface we decided to excavate the site in order to establish the stratigraphic order of the cultural materials, locate settlement structures (e.g., post-marks related to the daub found on the surface), and obtain charcoal for radiocarbon dating.

Before excavating the site, we systematically mapped the surface occurrence of cultural materials for the purpose of understanding their spatial distribution. We also systematically collected samples of potsherds, daub, bones and tuyere fragments. The pottery collection revealed the following patterns. Most of the Early Iron Age sherds (Kalambo tradition, see chapter 5) were undecorated or consisted of a single decorative elements such as grooves and channels. The assemblage was dominated by jars, globular pots, and large hemispherical bowls. Both TIW and Ivuna pottery were also found. The TIW assemblage comprised mainly of small hemispherical bowls and medium size pots. Ivuna ware consisted of a complex decorative patterns including diagonal cord-impressions, grass-roulettes, incisions, and bumpy, round, or wavy applications. They were dominated, in vessel forms, by large to medium globular pots and large hemispherical bowls. The more recent, Kirando pottery, were also present. They consisted of articulate decoration motifs, dominated by cross-hatches, as well as diagonal hatches and grass-roulette, bordered with a line or two of grooves. The dominant vessel assemblage included medium to small hemispherical bowls and

medium to small pots (for detailed descriptions of the pottery see chapter 5).

Two excavation units were opened in areas with concentration of artifacts; one measured 200X150 cm and the other measured 100X100 cm. Because the top soil was disturbed by ridge cultivation, we removed the top, ridged soil (about 50 cm high) in the two units before excavating. The cultural materials from the disturbed soil were recorded separately. These (disturbed materials) included 84 (6.4 kg) pieces of daub, 132 (0.79 kg) potsherds and 4 (0.05 kg) tuyeres.

Both units were excavated down to the sterile soil at 40 cm below datum. We recovered some fragmentary pottery, daub, tuyeres fragments, and small pieces of charcoal (Tables 6:15 and 6:16). The potsherds were dominated by the Ivuna tradition, consisting of large to medium pots either undecorated or having bump or ridge applications around the neck. Other types included Kalambo--especially the channeled ware--and the TIW. The daub pieces from unit 1 were found in a pile mixed with rocks (Fig. 6.17), a feature believed to have resulted from farm clearing.

Table 6.15: Materials Excavated from Unit 1, Site Hvlk-11.

LEVEL	VOL.	Daub		Potsherds		Bones		Tuyere Pieces		Slag		Miscellan.	
cm	cm^3 '000	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)
A:10	300	48	3.360	25	0.178			2	0.020			ch 1	0.001
B:20	300	13	0.990	33	0.263							ch 1	0.001
C:30	300	4	0.785	2	0.015								
D:40	300												
Total	1200	65	5.135	60	0.456			2	0.020				

Table 6.16: Materials Excavated from Unit 2, Site Hvlk-11.

LEVEL	VOL.	Daub		Potsherds		Bones		Tuyere Pieces		Slag		Miscellan.	
cm	cm^3 '000	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)
A:10	100			10	0.130								
B:20	100	15	0.050	9	0.043							ch 1*	0.001
C:30	100	1	0.027	4	0.022								
D:40	100												
Total	400	16	0.077	23	0.195								

Fig. 6.17 Pile of rocks and daub exposed in Unit 1, site Hvlk-11, Kirando.

Because of the low amount of cultural materials from the excavation units, we decided to open shovel tests for the purpose of identifying area(s) rich in cultural materials for more excavation. A total of 42, 50 X 50 cm, shovel tests were dug along two different lines. The first line, with thirteen pits, placed 20 m apart, was located 50 m from the swampy

vegetation in a zone of limited cultivation (Fig. 6.16). The pits varied in depth between 30 and 40 cm. Only four pits (ST # 1, 2, 4 and 8) yielded cultural materials (potsherds -- ranging in number between seven and one per pit -- plus a sherd of a clay tobacco-pipe). Most of the potsherds were recent. The soil, which generally comprised of coarse-grained sand, showed three stratigraphic layers: gray to brown at the top, pinkish at the middle, and reddish yellow at the bottom that overlay a basement of limestone.

The second line, 29 pits placed 40 m apart (Fig 6.16), was located within the swampy area (water had receded). Seven pits yielded cultural materials as follows: ST # 15, a blue glass bead 10 cm below surface; ST # 19, a potsherd, 50 cm below surface; ST # 30, charcoal, 55 cm below surface; ST # 32, six potsherds 00-40 cm below surface; ST # 33, two potsherds 20-58 cm below surface; ST # 34, a potsherd, 40 cm below surface; and ST # 38, a tuyere fragment and a potsherd, 00-16 cm below surface. The soil also showed three distinctive layers: black, organic soil at the top; red, coarse sand mixed with lake shells in the middle; and ashy-white, fine-grained sand at the bottom. These were underlaid by a basement of limestone in the south and laterite in the north.

The shovel tests indicated that the lower area had been covered by lake water in the past (very likely the time when the upper area was occupied), which accounts for the dearth of cultural materials below ground. There was, therefore, no reason to open larger excavation units.

Two charcoal samples from this site have been dated (Table 6.22). The first (lab. # Beta 63010/ETH-10614), obtained in a daub matrix 16 cm below ground in unit 2, was dated by the Accelerator Mass Spectrometer Technique (AMS) to 595 ± 55 bp, calibrated AD 1400 or ranging from A.D.1291-1435. The second sample (lab. # Beta 71388/CAMS 12707) obtained from a shovel-test (#30) dug at the base of the hill, was also dated by the AMS technique and dates to 260 ± 60 bp, calibrated to A.D. 1660 (ranging from A.D. 1500-1820). These C14 dates and the pottery collection (both surface and subsurface) show that this site, which is occupied today, was inhabited throughout the later Iron Age.

Hvlk-19, Kirando

The site is located on latitude 7°33'30" south and longitude 30°48'50" east, about 10 km southeast of Masolo village along the Lusambu river. The cave, which according to oral accounts has been used for generations, is still being used by hunters, honey collectors, and fishermen as a seasonal camp. During the survey we found several utensils, including water gourds, cooking pots, flour-storage pots (some with flour in them), as well as animal hides (used as sleeping mats) in the cave (Fig. 5.5). The river is seasonal but there is a permanent spring 300 m east of the cave.

Because it is located only 300 m away from an ironworking site (Hvlk-20) we suspected that the cave was also used by the iron smelters. The site was therefore excavated in

anticipation of finding non-technological cultural materials that could help to explain the ways of life of the katukutu iron smelters.

A trench measuring 150X50 cm was dug in the eastern end of the cave. This was excavated to bedrock 60 cm below surface. It yielded pieces of animal bones, potsherds, gourd-sherds, a buoy, a piece of a bivalve shell (probably used as a spoon), and some charcoal (Table 6.17). The bones included two ribs and one femur of an impala (Aepyceros melampus), two ribs of a zebra (Equus quagga), a premolar of a wild-pig (Potamonchoerus porcus), and a rodent incisor. The findings indicate that the cave had been used mainly by hunters and fishing folks.

One charcoal sample (Lab. # Beta 63013) obtained at 52 cm below ground, has been dated to 300 ± 70 bp, calibrated to A.D. 1640 (or ranging from A.D. 1446-1954).

Table 6.17: Materials Excavated from Site Hvlk-19.

LEVEL	VOL.	Daub		Potsherds		Bones		Tuyere Pieces		Slag		Miscellan.	
cm	cm^3 '000	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)
A:15	113			7	0.055	2	0.018					gd 1 by 1	0.003 0.001
B:30	113												
C:45	113			3	0.014	2	0.002					ch 1	0.003
D:60	113					4	0.003					ch 1*	0.003
Total	452			10	0.069	8	0.023						

Hvlk-26, Kirando

The site is located 7°26'44" south, 30°41'00" east, 250 m northeast of site Hvlk-25 (down-valley) and close to a dry stream that passes in the middle of the valley. It consisted of a concentration of tuyere fragments on the surface and an outcrop of potsherds along a gully wall about 60 cm below ground. Most of the sherds were highly weathered, but those that were better preserved were of the Kalambo tradition: they had thickened and/or bevelled rims, rough paste, and were tempered with quartz. Two vessels were represented: a large and thick globular pot with a thickened rim and an open bowl with thickened and bevelled rim (Fig. 5.12).

The tuyere fragments belonged to the katukutu technology and they were, therefore, younger than the pottery. The absence of other technological materials such as furnaces led us to suspect that the tuyere fragments were in a secondary location, very likely they had been transported down stream and deposited there from site Hvlk-25.

The soil at this site was bare and extremely hard. We managed to excavate only one unit, measuring 100X100X50 cm. It yielded 14 potsherds of the Kalambo ware most of which were highly weathered. However, in both paste and temper they were similar to those collected from the gully wall.

Hvlk-58, Kirando

Located on latitude 7°20'10" and longitude 30°38'00" and extending 400 m N-S and 200 m E-W, site Hvlk-58 consisted of

scatters and concentrations of potsherds, tuyere fragments, slag, and burnt clay (daub and furnace wall) on both sides of the Mtakuja-Sokoso footpath, about 700 m north of the Kavunja river (Fig. 6.18). There were two termitaries in the vicinity, but neither of them had any direct relationship with the ironworking artifacts (slag and tuyere) sparsely scattered over the site since no furnace was found around them. These materials probably were deposited by subsequent residents from the neighboring ironworking site, Hvlk-56, located 500 m south of Hvlk-58.

The site was excavated for the purpose of examining the stratigraphic position of the cultural materials found on the surface, especially pottery which, given its ubiquity, had a potential for studying the cultural change through time.

Before excavating the site we conducted a rigorous surface investigation (in addition to that conducted during survey). The entire site, measuring 400X400 m, was divided into 2 m wide strips and every alternating strip was thoroughly investigated, recording all cultural materials found on it. A total of 32,000 square meters or 40% of the site was covered in this investigation. At the end of this investigation we observed that all five pottery traditions (Kalambo, TIW, Ivuna, Katukutu, and Kirando) known from the southeastern Lake Tanganyika shore were present at the site (Table 6.21). This indicated that this was a multi-component site.

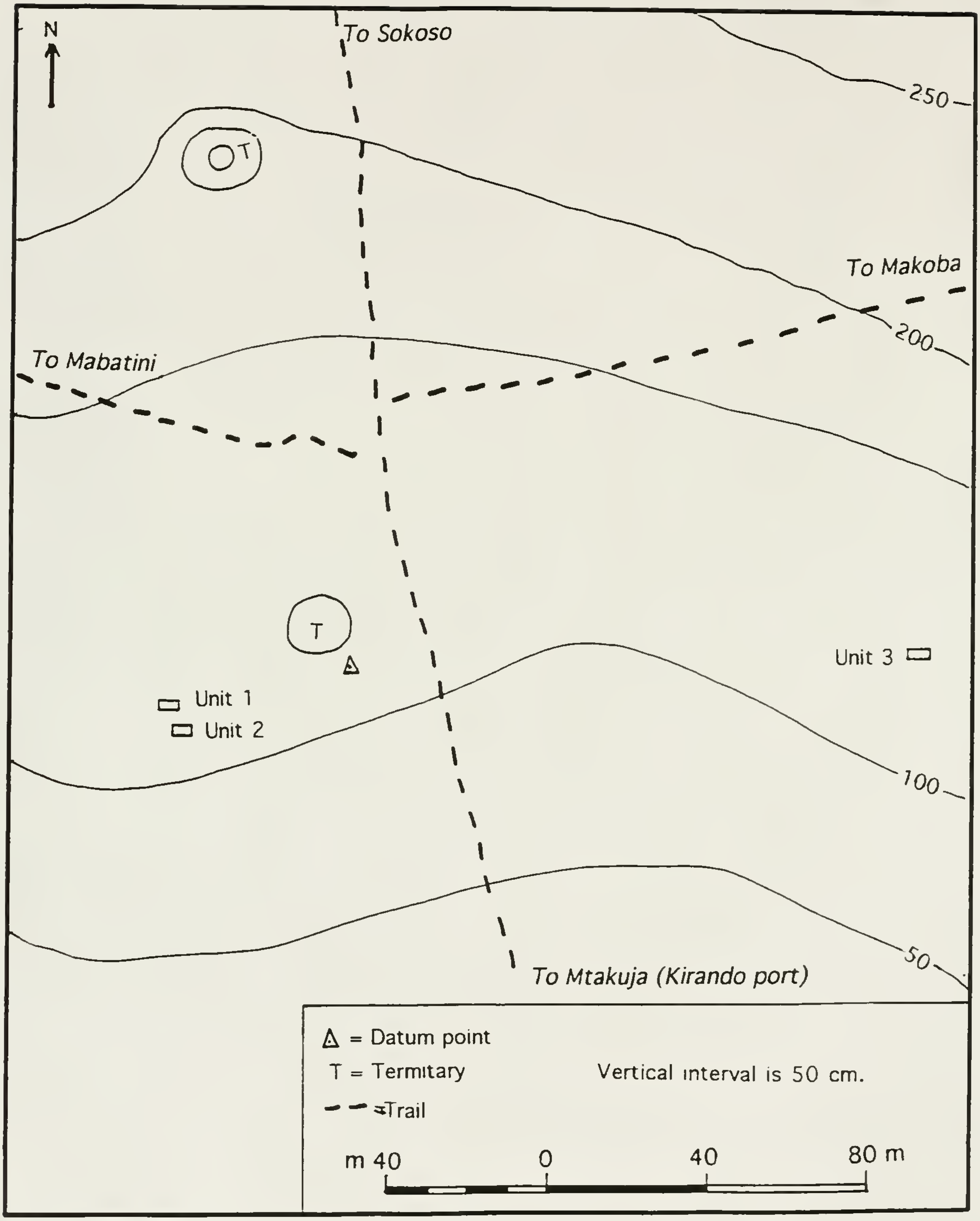

Fig. 6.18 Plan of site Hvlk-58, Kirando

The investigation also revealed two areas with a concentration of artifacts, one to the east and the other to the west of the footpath. Three excavation units measuring 150X100 cm each were opened in the areas with artifact concentrations. Units 1 and 2 were located four meters apart on the western side of the site while unit 3 was opened 200 m east of units 1 and 2 (Fig. 6.18). The first two units were excavated down to 40 cm. Unit 3 had a deeper cultural horizon and was dug to 45 cm. The three units yielded a significant amount of pottery, as well as a few daub and tuyere fragments, animal bones (most highly weathered), pieces of charcoal, a copper bead, and a piece of iron rod (Tables 6.18, 6.19 and 6.20).

Table 6.18: Materials Excavated from Unit 1, Site Hvlk-58

LEVEL	VOL.	Daub		Potsherds		Bones		Tuyere Pieces		Slag		Miscellan.	
cm	cm^3 '000	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)
A:10	150			53	0.718			6	0.104			ch 1	0.003
B:20	150	3	0.014	25	0.213	1	0.005					bn 1	0.004
C:30	150	5	0.038	38	0.435			3	0.017			bd 1	0.005
D:40	150			5	0.024					1	0.008		
Total	600	8	0.052	121	1.390	1	0.005	9	0.121	1	0.008		

Table 6.19: Materials Excavated from Unit 2, Site Hvlk-58

LEVEL	VOL.	Daub		Potsherds		Bones		Tuyere Pieces		Slag		Miscellan.	
cm	cm^3 '000	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)
A:10	150			27	0.205	2	0.011					bn 2	0.011
B:20	150			67	0.602								
C:30	150			40	0.394			2	0.029			mk 1	0.093
D:40	150			2	0.026			1	0.012				
Total	600			136	1.227	2	0.011	3	0.041				

Table 6.20: Materials Excavated from Unit 3, Site Hvlk-58

LEVEL	VOL.	Daub		Potsherds		Bones		Tuyere Pieces		Slag		Miscellan.	
cm	cm^3 '000	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)	#	wgt (kg)
A:10	150			45	0.597	5	0.009			1	0.002	bn 5	0.009
B:20	150	1	0.017	51	0.434			3	0.044	1	0.030		
C:30	150			70	0.713	1	0.003	6	0.080			bn 1 ir 1	0.003 0.004
D:40	150			20	0.264							ch 2*	0.008
E:45	75												
Total	675	1	0.017	186	2.008	6	0.012	9	0.124	2	0.032		

bd = bead; bn = bone; ch = charcoal; ir = iron rod; mk = mkungu.

The potsherds were similar to those found on the surface. Stratigraphically, the pottery conformed well with the general sequence explained in chapter 5; the older pottery (Kalambo and TIW) were concentrated at the bottom and the younger (Ivuna, Katukutu, and Kirando-Tabwa) pottery at the top (Table 6.21).

Table 6.21: Distribution of pottery types according to stratigraphy

Tradit.	Level A: 10 cm	Level B: 20 cm	Level C: 30 cm	Level D: 40 cm	Level E: 45 cm	Sub-total	Surfa.[11]	Grand Total
Kirando	11	3	4			18	23	41
Katukutu	27	20	4			51	65	116
Ivuna	51	17	4			72	21	93
TIW	30	87	122	18		257	85	342
Kalambo	4	4	12	9		29	17	46
Total	123	131	146	27		427	211	638

11 The materials were collected from 32,000 square meters (for details see chapter five, site Hvlk-58).

Unit 3 revealed an iron nail (Fig. 6.19b), one of two pieces of metal excavated during the research project (the other was a piece of hoe from Hvlk-35). The nail was cylindrical in shape, measured 2.9 cm in length, 0.5 cm in diameter, weighed 4 grams, and was highly corroded. Metallographic analysis indicated that both artifacts were made from indigenous iron (see details in chapter 7, samples 129-1 and 284-1).

One of the ceramics uncovered from Unit 2 was a clay chalice with a red slip on the outside and cross-hatches on both ends (Fig. 6.19a). The local oral accounts hold that until the first quarter of this century some elders used such vessels called <u>mikungu</u> (<u>mkungu</u> sing.) to burn ritualistic herbs when they wanted to "communicate" with <u>mizimu</u> (ancestral spirits). Earlier, during the surface investigation we found another <u>mkungu</u>. The two differed from each other in finish, shape, and paste. The excavated one was made from medium-grain red clay, had two cups, was decorated and red slipped on its exterior, and was burnished inside. The one found on the surface was made from brown, fine-grained brown clay, was plain, had a single cup, and a flat stand. It is difficult to tell with this limited sample whether these differences reflect a technological change, a difference in the social status of the users, or local variability.

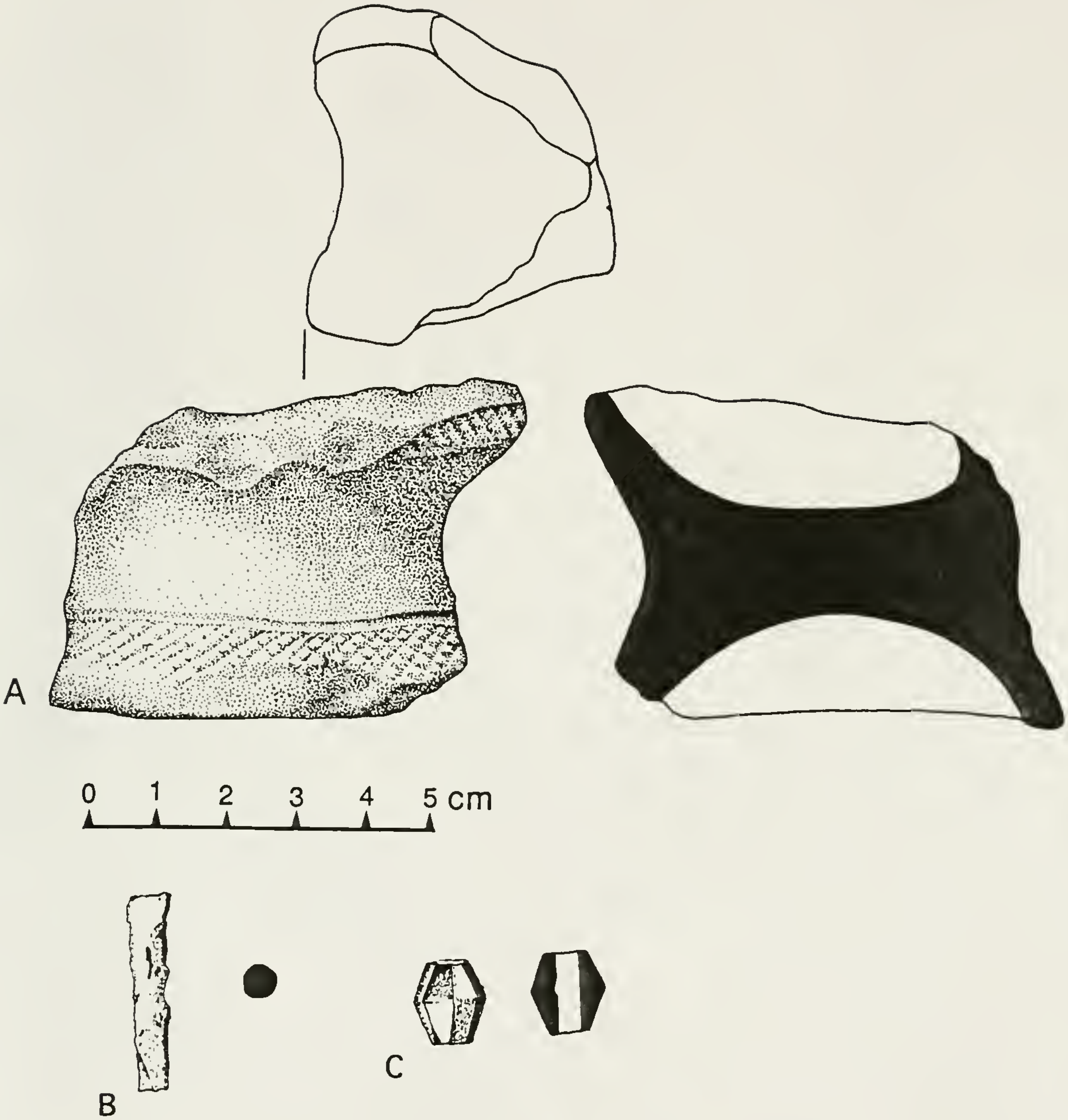

Fig. 6.19 Some materials excavated from site Hvlk-58, Kirando. (a) "Mkungu" from Unit 2; (b) nail from Unit 3; and (c) copper bead from Unit 1.

The bead found in unit 1 was a standard truncated bicone (Beck 1973) that measured 1.2 cm long and 1.1 cm wide, and weighed 5 grams (Fig. 6.19c). It had a thin crust of green substance (removable by scratching with a hard substance, e.g iron). Chemical analysis showed that the bead was made of copper (with some aluminum, silica, and iron), and the crust consisted of copper oxide. Metal beads found in Africa were locally made, according to Sleen (1980), and glass beads were imported. The source of the bead is an interesting question. Given the wide occurrence of copper in the research area[12] and in the neighboring south (Katanga copper belt in Zambia and Zaire) and north (Karagwe) (Kjekshus 1977), I am inclined to believe that the copper bead was manufactured somewhere in the interior of East and Central Africa. Rigorous investigation, especially at the headquarters of the historical chiefdoms near the research area such as Lyangalile, Milansi, Nkansi, Tafuna, and Luba, may lead us to the more specific information on copper bead making in the region.

Regardless of the source, this evidence, considered together with the TIW pottery tradition and a C14 date of 1040± 80 bp (Beta-71390), calibrated to A.D. 1020, is intriguing enough to make archaeologists and historians reexamine the culture history of the East African interior especially in terms of commercial and social interactions between the Indian Ocean littoral and the Great Lakes Region on the one hand and between

[12] As noted in chapter 2, a deposit consisting of copper, lead, silver and gold was located in Mpanda district, about 150 km northeast of Kirando. Commercial production ceased in the 1950s after the exhaustion of the deposit.

different centers within the interior on the other during the early second millennium A.D. (see more discussion in chapter 8).

In sum, the findings from site Hvlk-58 indicate that the site is a multi-component one, occupied and abandoned at least three times: 1) at the end of the last millennium (suggested by the date and the TIW); 2) sometime during the middle of this millennium (suggested by the presence of the katukutu pottery); and 3) during the last two centuries (suggested by slag, and tuyere, and vintengwe remnants).

Table 6.22 C14 Dates from Excavated Sites

Sample No.	Provenance	Site Type	Uncalibrated Dates (bp)	Calibrated (AD) Dates, 2 sigma, 95% accuracy
Beta-71386	Hvlk-1, Unit 2, Block 2, 38 cm	katukutu ironworking	280 ± 60 bp	1470-1950
Beta-71387	Hvlk-1, Unit 2, Block 2, 53 cm	katukutu ironworking	200 ± 80 bp	1530-1950
Beta-63011	Hvlk-17, Unit 1, Block 2, 42 cm.	katukutu ironworking	430 ± 70 bp	1400-1640
Beta-63012	Hvlk-17, Unit 1, Block 2, 41 cm.	katukutu ironworking	350 ± 70 bp	1430-1950
Beta-63014	Hvlk-25, Unit 1, Block 1, 35 cm.	katukutu ironworking	100 ± 70 bp	1660-1950
Beta-63015	Hvlk-25, Unit 2, Block 2, 38 cm.	katukutu ironworking	310 ± 60 bp	1450-1950
Beta-64657	Hvlk-32, Unit 1, Block 2, 82 cm.	katukutu ironworking	290 ± 80 bp	1440-1950
Beta-71392	Ialm-1, Unit 3, Block 2, 55 cm.	katukutu ironworking	360 ± 80 bp	1430-1950
Beta-71393	Ialm-1, Unit 5, Block 2, 60 cm.	katukutu ironworking	230 ± 50 bp	1650-1950
Beta-63017	Hvlk-35, Unit 2, 24 cm.	"Barongo" ironworking	20 ± 50 bp	1700-1950
Beta-71389	Hvlk-39, Unit 1, Block 2, 75 cm.	malungu ironworking	30 ± 50 bp	1890-1950
Beta-63018	Hxlo-2, Unit 1, 25 cm.	malungu ironworking	60 ± 50 bp	1680-1950
Beta-63010/ ETH-10614 (AMS)	Hvlk-11, Unit 2, 16 cm.	habitation	595 ± 55 bp	1290-1430
Beta-71388/ CAMS-12707 (AMS)	Hvlk-11, Shovel Test # 30, 55 cm.	habitation	250 ± 60 bp	1500-1950
Beta-63013	Hvlk-19, 52 cm	habitation	300 ± 70 bp	1450-1950
Beta-71390	Hvlk-58, Unit 3, 32 cm.	habitation	1040 ± 80 bp	890-1220

CHAPTER 7

LABORATORY EVIDENCE

This chapter attempts to reconstruct some smelting and smithing techniques based on phase and elemental analyses of fifty-four samples of slag, blooms, and iron objects found during this research project (appendix C). Laboratory analysis of metallurgical materials can be conducted by using several techniques, including Induced Coupled Plasma spectroscopy (ICP), Atomic Absorption Spectroscopy (AAS), X-ray fluorescence analysis (XRF), X-ray diffraction, Energy Dispersal Spectroscopy (EDS), and metallography. It is recommended (Killick 1990) that more than one technique should be used on the same material in order to achieve more reliable results. The following work incorporated metallography (including photomicrographic documentation) for phase analysis and Energy Dispersal Spectroscopy (EDS) for elemental analysis. The questions asked in this chapter and the materials analyzed (slag, bloom, and metal objects) are those that can best be dealt with by the two techniques (metallographic and EDS).

The laboratory evidence presented in this chapter supplements surface and subsurface archaeological evidence provided in chapters 5 and 6 above. This laboratory evidence is

especially important for the katukutu type of technology as it is very poorly known by local people and there is very little information about it in oral traditions. Additionally, the katukutu technology is unique wher compared with other iron technologies found in southwestern Tanzania. The most striking characteristics include the short (70-120 cm) and globular shape of the furnaces, the paucity of slag, and the abundance of tuyeres.

These features and others prompted many questions when we first encountered furnaces and other katukutu artifacts in the field. Some questions were answered by surface and excavated data. These included to determine whether the sites were used for smelting or refining; to locate tuyere ports; and to establish the number of tuyeres used in each port. A few questions, however, remained unsolved or were not satisfactorily answered. For example, we needed to confirm that the katukutu involved a ferrous as opposed to nonferrous technology or that it was a bloomery as opposed to blast technology (producing cast iron), as well as account for the ubiquity of tuyeres and paucity of slag.

The analyses also covered samples from the malungu and the Barongo-type technologies. This was done in order to compare the three technologies as well as to supplement oral accounts of the malungu and the Barongo-type technologies. Aside from samples that came directly from smelting such as slag and bloom, the analyses dealt with iron artifacts recovered during the research project. The objectives were to determine

the source of the metals and reconstruct the techniques used in fabricating them, such as welding, folding, carburization, decarburization, quenching, tempering, and annealing.

Seven problems (or questions) were identified, and are presented in this chapter. Five of these relate to smelting materials such as ore, slag, and bloom and two relate to iron artifacts. Problems in the first category include: 1) to confirm that the katukutu technology is ferrous as opposed to non-ferrous metallurgical process; 2) to determine whether the katukutu technology involved bloomery or blast process; 3) to determine whether blooms in the katukutu furnaces were left to cool inside the furnaces or were raked out soon after smelting; 4) to compare the technological efficiency between the three technologies (katukutu, malungu and Barongo-type); and 5) to account for the paucity of slag in the katukutu technology. The problems dealt with under the category of metal artifacts are, 1) to determine whether the iron used to make the artifacts was indigenous or imported (industrial); and 2) to understand some forging techniques used to fabricate the materials. These problems are discussed below in the same order as outlined here.

1. <u>To confirm that the katukutu technology is ferrous as opposed to non-ferrous metallurgical process</u>

The unique characteristics of the <u>katukutu</u> technology, including the globular shape, the paucity of slag, and the abundance of tuyeres prompted the question as to whether this technology involved iron or other metals. Although excavations yielded some pieces of iron ore and metallic (ferrous) slag (type B-m) these materials could not be taken as definitive proof of ferrous metallurgy; sometimes the smelting of pre-industrial nonferrous metals such as copper and lead involved iron ore as fluxing materials (Rostoker and Bronson 1990). Consequently, "nearly all ancient metallurgical slag are ferrous silicates, no matter whether they are the byproducts of iron or non-ferrous metal production" (Bachmann 1982:3). Van der Merwe, discusses a concrete case, the Iron Age site at Pharaborwa (northeastern South Africa), where both copper and iron were smelted. He warns that superficial investigation can easily lead to serious confusion between the two metallurgical types (van der Merwe 1980). "Because copper ores like malachite are frequently associated with iron oxides," van der Merwe observes, "natural fluxing presumably also occurs on many occasions. The resultant slag are iron-rich and have led investigators to mistake copper smelting sites for example with iron smelting" (van der Merwe 1980: 488). Van der Merwe even hypothesizes that this type of slag misidentification may have "contributed to the apparent lack of information about copper production in

Africa especially in the Early Iron Age" (van der Merwe 1980: 488).

The presence of both copper and lead near the research area (southwestern Tanzania) accentuated the need for rigorous examination for metal identification. Copper is mined in both Zambia and Zaire (Fig. 1.1) and historical and archaeological evidence show that indigenous copper-working has been practiced in the Katanga region across the border between western Zambia and southern Zaire for over a millennium (Childs 1989, 1991c). Additionally, a large lead-silver-copper-gold deposit located at Uruwira, Mpanda District, 150 km north of Kirando, was commercially mined in the 1950s (Moffett 1958). Although we do not know if any of these metals were smelted there in precolonial times, their mere presence in commercial quantities is a strong reason to make one cautious. It was imperative to use microscopic techniques given that the physical evidence was indecisive.

Laboratory indices. Because iron ore was used in copper fluxing, either intentionally or accidentally, nearly all per-industrial metallurgical slag contain some iron. However, slag from nonferrous metallurgy can be distinguished from ferrous metallurgical slag by determining the amount of copper or lead which appear as entrapped metal globules or prills in the slag. In nonferrous metallurgy the copper or lead values converted by calculation to their oxides will amount to more than one percent up to as much as 10 percent. On the other hand, iron smelting

slag usually contains less than 0.1 percent of either lead or copper (Rostoker and Bronson 1990).

Analysis and findings. Twenty-three samples from katukutu sites were analyzed: six samples with the EDS method (to determine their chemical composition) and all twenty-three samples were analyzed with metallographic technique to identify phases. These samples were selected from four different katukutu sites: Hvlk-1, Hvlk-17, and Hvlk-25 from Kirando (Fig. 4.2) and Ialm-1 from King'ombe (Fig. 4.3). The specific materials included ore pieces, slag, blooms, and vitrified furnace walls as specified in Appendix C. Samples for EDS technique, for example, included two blooms, one blob-like, non-metallic slag (B-n), one mottled slag (C-n), one ore piece, and one piece of vitrified furnace wall. None of them showed any trace of copper or lead. The elements found, arranged by a rough descending order of quantity, included iron (Fe), silica (Si), aluminum (Al), calcium (Ca), oxygen (O), potassium (K), phosphorus (P), titanium (Ti), manganese (Mn), and chlorine (Cl) (see Fig. 7.1 and 7.2, as well as summary in Appendix C).

Conclusion. Laboratory analysis confirms that the katukutu technology is ferrous.

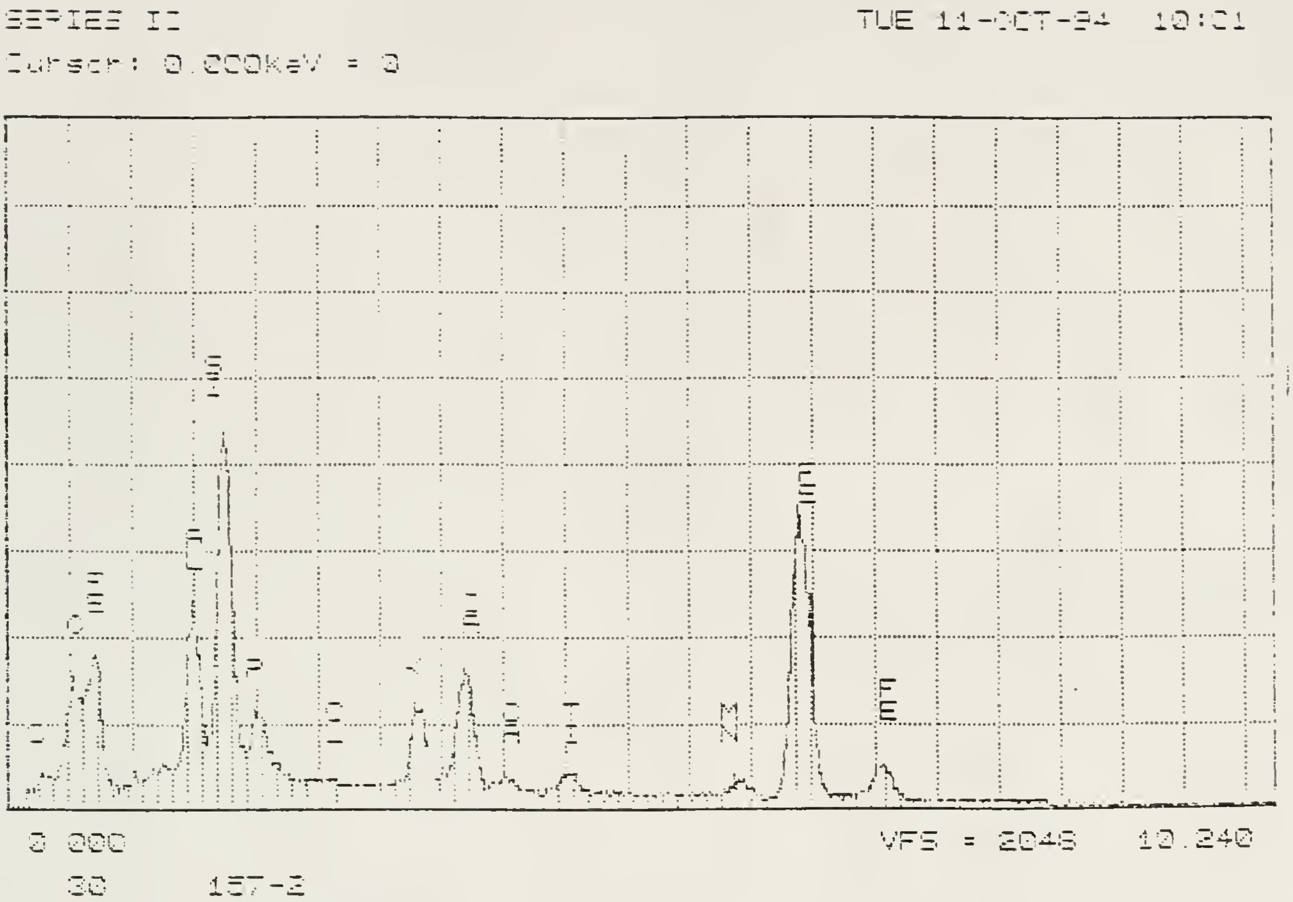

Fig. 7.1 Elemental analysis of a <u>katukutu</u> bloom, sample 157-2, from site Hvlk-25, Unit 1 Block 2 (inside the furnace), Level D: 50-60 cm below datum point. Elements that are present in this sample are also found in other <u>katukutu</u> slag that have been examined (see appendix C). The carbon (C) present in the chart is most likely a result of the carbon coating applied on the sample prior to EDS reading.

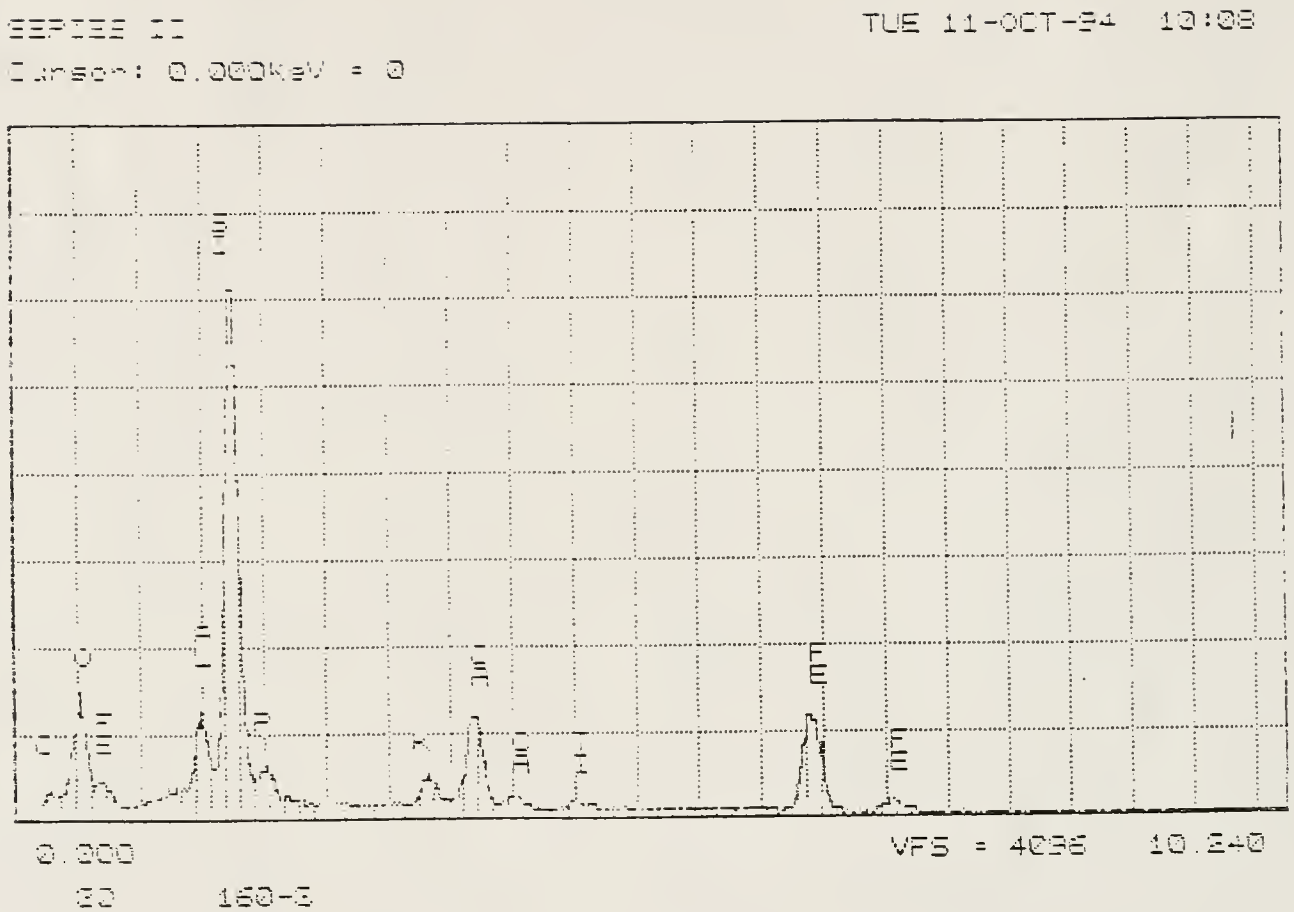

Fig. 7.2 Elemental analysis of a <u>katukutu</u> slag, sample 160-3, type C-n (dripping) slag from site Hvlk-25, Unit 2 Block 1 (outside the furnace), level A: 00-20 cm below datum point.

2. Determining whether the katukutu technology involved bloomery or blast process

Pre-industrial iron technology is often divided into two categories, bloomery and blast, based on the end-product of smelting: bloom and cast iron respectively (van der Merwe 1980; David et al. 1989). It should, however, be noted that this division is artificial because often times the two categories overlap (as will be demonstrated below). In a typical bloomery operation iron metal is smelted from ore at the temperature below the melting point of iron (Childs in press). That is to say, a solid state reduction of oxide ores takes place, resulting in iron particles which agglomerate at the bottom of the furnace in a form of a bloom--a porous mass of metal (wrought iron or steel) often mixed with some macro- and micro-particles of slag and remnant charcoal fuel.

On the contrary, a blast furnace operation produces liquid iron with a high carbon content (2-5%) and is usually tapped (David et al. 1989). It should be noted that the formation of cast iron does not need to exceed the melting point of pure iron, that is 1538° C. The melting point varies depending on the chemistry inside the furnace, as when other elements such as carbon alloy with iron (Fe). Such factors can reduce the melting point to as low as 1148° C when, for example, the carbon content in the furnace exceeds 2.11% in weight as illustrated in the binary phase diagram[1] (Fig 7.3). This figure shows how the

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[1] A phase diagram is an illustration showing the axes of temperature and elemental composition that describes the different phases that may occur in an alloy with change in either composition or temperature (Scott 1991). A binary phase diagram consists of two elements, in this case, iron and carbon.

melting point of iron varies in relation to the weight percent of carbon.

One way of attaining a high carbon content in the furnace and consequently, cast iron is to raise the fuel to ore ratio. As Rostoker and Bronson observe:

> In general, raising the fuel to ore ratio in smelting has several consequences: the temperature within the furnace rises, more air is needed for complete combustion, and gases with a higher CO/CO_2 ratio reach further up the shaft from the combustion zone. The result is that the metal is more effectively reduced and partially carburized. If carburization proceeds to the saturation point, the iron melts, a different slag chemistry is introduced, and recovery efficiencies of metal from ore improve dramatically. If this happens all across the hearth, the furnace is no longer technically a bloomery since its product is cast rather than bloom iron (Rostoker and Bronson 1990:97).

For a long time it was believed that indigenous African metallurgists did not know how to produce cast iron, though Cline noted in his classic monograph, Mining and Metallurgy in Negro Africa that it was accidental and that: "production of cast iron [was] a blunder" (Cline 1937:53). Since the last decade, archaeologists are finding new evidence which prove that the production of cast iron in Africa was not always a "blunder", but also a deliberate technological undertaking.

Archaeometallurgists, however, should use phase diagrams with great caution (only as heuristic devices) because both thermal and chemical dynamics operating in pre-industrial furnaces were highly variable and complex (see, for example, the elemental analysis presented in problem #1 above; also Killick (1990)).

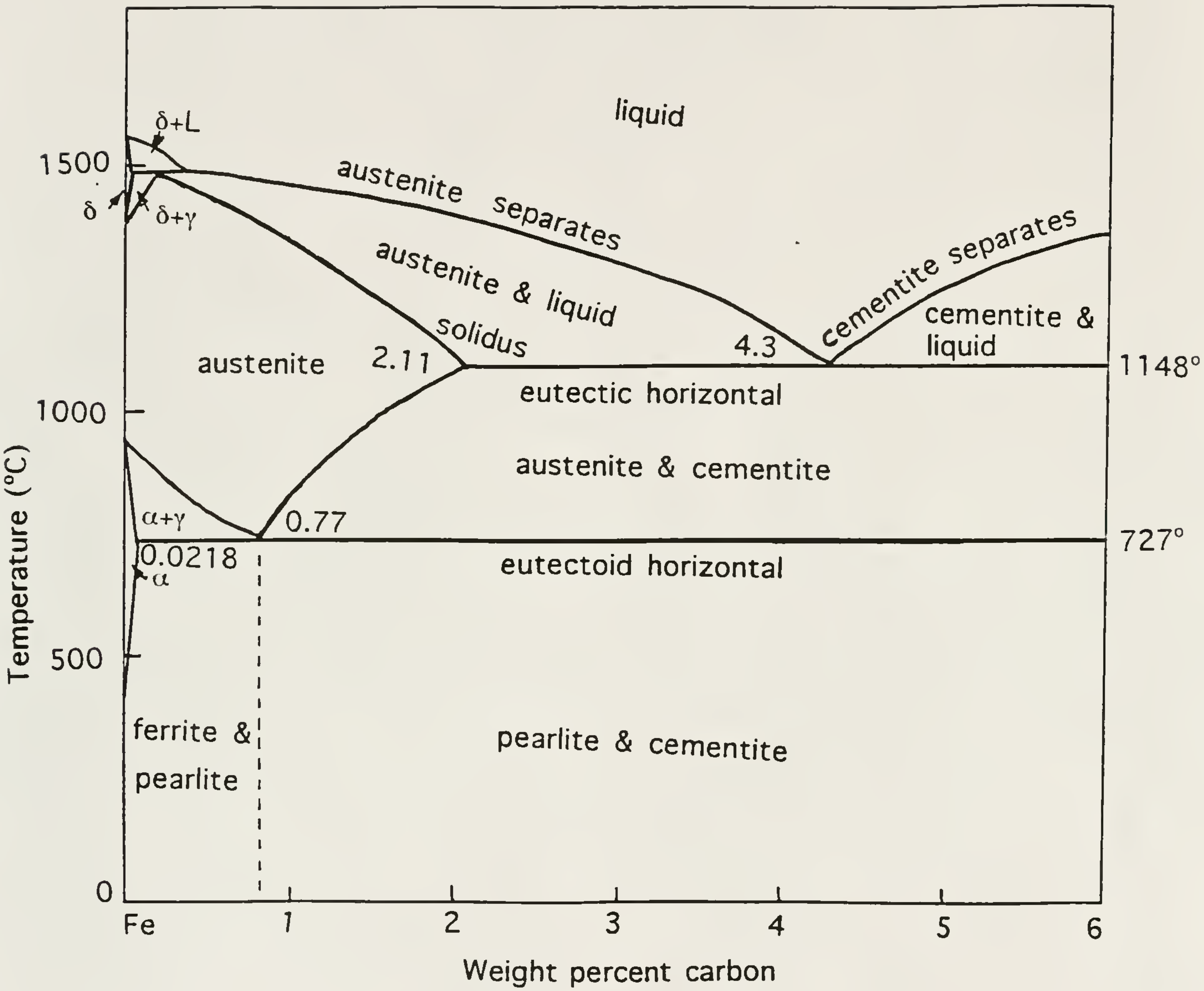

Fig. 7.3 The Iron-Carbon diagram. (Based (with modifications) on Askeland (1989:331) and Scott (1991:132)).

In their archaeometallurgical experiments in Mafa, north Cameroon, Nicholas David and his colleagues learned that "a smelt in a Mafa down-draft furnace produced cast iron in addition to steel and low-carbon iron", and that the local metallurgists "further [processed] these products in a forge to decarburize the high-carbon materials [to get] forgeable, weldable steel quite suitable for the manufacture of traditional implements" (David et al. 1989:183). After this observation, David et al. conclude that "the production of cast iron was clearly not a mistake, since Dokwaza used standard techniques to decarburize cast iron to steel in the forge" (David et al. 1989:198).

Furthermore, Peter Schmidt and his colleagues found that cast iron, steel and wrought iron were concurrently produced in the "bloomery" process in their archaeological investigations and archaeometallurgical experiments in Buhaya, northwestern Tanzania. They also noted that the iron smiths were aware of this mixture and that they had developed special techniques of dealing with such a complex product (Childs in press).

Since we now know that intentional cast iron was also produced in Africa, students of indigenous African metallurgy need to be more cautious to avoid the past mistakes (archaeologists believed that Africa consisted of only the direct (= bloomery) process). Rigorous scrutiny is specially important when dealing with technologies about which we know very little, such as the katukutu technology.

The most diagnostic physical evidence of cast iron would be its shape. Cast iron, because it is often tapped, appears in forms of ingots with a smooth surface. But from what we know so far about cast iron in Africa (David et al. 1989; Childs in press), it did not come out as an ingot; instead it was usually as pellets and pieces in the same bloom that also contained wrought iron and steel. In the Mafa experiments, for example, David et al. report that "of a sample of iron pellets and fragments recovered from the bloom, about half was found to consist of cast iron, the remainder of steel and low-carbon iron" (David et al. 1989:197). It is, therefore, difficult to determine the presence of cast iron from the African bloomery process by examining the external or physical properties alone.

Laboratory indices. The two operations (bloomery and blast) can be distinguished by observing the amount of carbon in the end-product of smelting. A bloomery process produces a ferrous material with a variable carbon content ranging between wrought iron with less than 0.1% carbon to steel with 0.1-2.0% carbon. By contrast, cast iron, a product of a blast operation, has a high carbon content, ranging from two to five percent (2-4%) (David et al. 1989; Scot 1991).

Although it is argued here that intentional production of cast iron was being practiced by indigenous African metallurgists, it would be misleading to deny that "unintentional" cast iron was also produced in the bloomery process. Given the thermal and chemical variation inside the smelting furnaces, bloomery processes could easily result in

"unintentional" cast iron. Intentional and unintentional cast iron can be distinguished by the amount of cast iron present in the end-product. The fifty percent cast iron content observed in the Mafa experiments "probably overestimates the true ration of case iron to steel and low carbon iron", David et al. note (1998:197-8). Unfortunately, David et al. (1989) do not set a fixed scale with which to determine intentional production of cast iron. I would argue (from intuition) that even when the amount of cast iron is as low as 25% we should label it as intentional provided that the content is proven to be consistent in space and/or time.

Because cast iron is hard and brittle it is difficult to forge without first decarburizing it. Open-hearth forges, common in Africa, have an automatic decarburizing effect. But it would, probably be difficult to forge a bloom with over 25% cast iron without a reinforced decarburization. When it is established that the iron-forgers regularly reinforce decarburization, it is an indication that the production of cast iron is also regular and, therefore, intentional (David et al. 1989; Childs in press).

Slag can also yield diagnostic characteristics regarding this problem. Slag from blast processes is very low in iron oxide because of the strongly reducing nature of blast furnace gases (Rostoker and Bronson 1990). That is to say, if the dominant microconstituents in slag are the free iron oxides (magnetite, wustite, hematite), it indicates that the slag emanated from a bloomery furnace (Killick 1990; Childs in

press) and when the dominant microconstituents are iron-free slag such as SiO_2-Al_2O_3-CaO, then this strongly indicates that the slag emanated from blast furnace. Additionally, a piece of cast iron contains very little slag, and often none at all.

Analysis and findings. Phase identification was conducted using the metallographic technique on five blooms and thirteen slag samples. The blooms (etched with 2% nital) consisted of ferrite (appearing as white and gray polygons in Fig. 7.4). All eight slag samples were dominated by iron oxides (magnetite--angular and dendritic, white phases in Fig. 7.5 and wustite--large, round, and dendritic phase in Fig. 7.6 and 7.7).

Conclusion. The dominance of iron oxides in the slag and the absence of cast iron metal in the blooms indicate that katukutu was a bloomery iron technology.

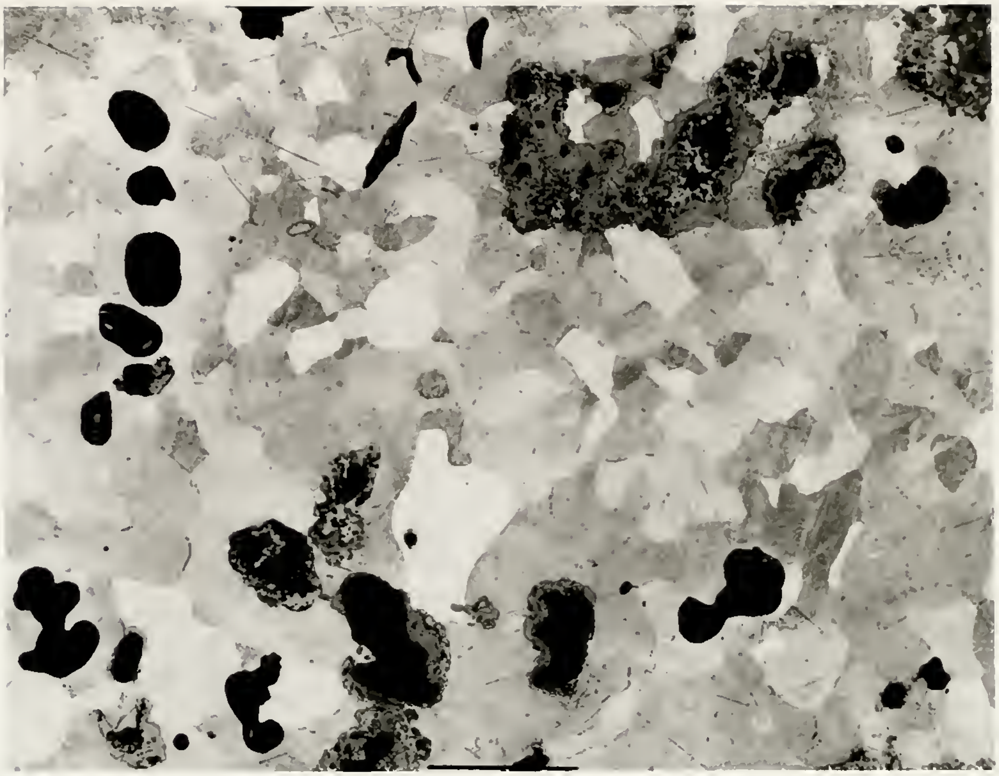

Fig. 7.4 Photomicrograph of a bloom, sample 154-1, showing coarse polygonal grains of ferrite. The variation in color (white and gray) results from differential orientation of the grains with relation to the specimen surface (Habraken and Brouwer 1967). Black areas are pores (some of them--top, right and bottom, left--are surrounded by corrosion). (Etched with 2% nital, 3 seconds; scale is 100 μm). X100

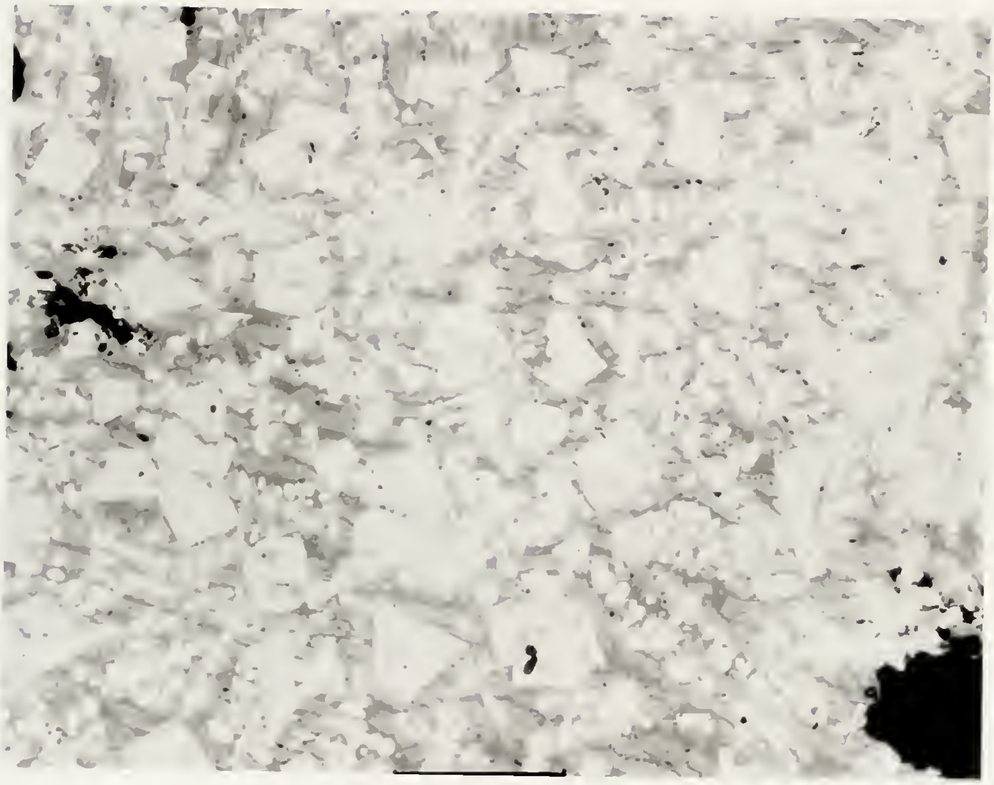

Fig. 7.5 Photomicrograph of a slag sample, lab # 159-2, showing magnetite (bright angular particles) as the dominant phase. Other phases include wustite (white dendrites), fayalite (light-gray lathes), and glass (dark-gray). The black areas are pores. (Scale is 100 μm). X200

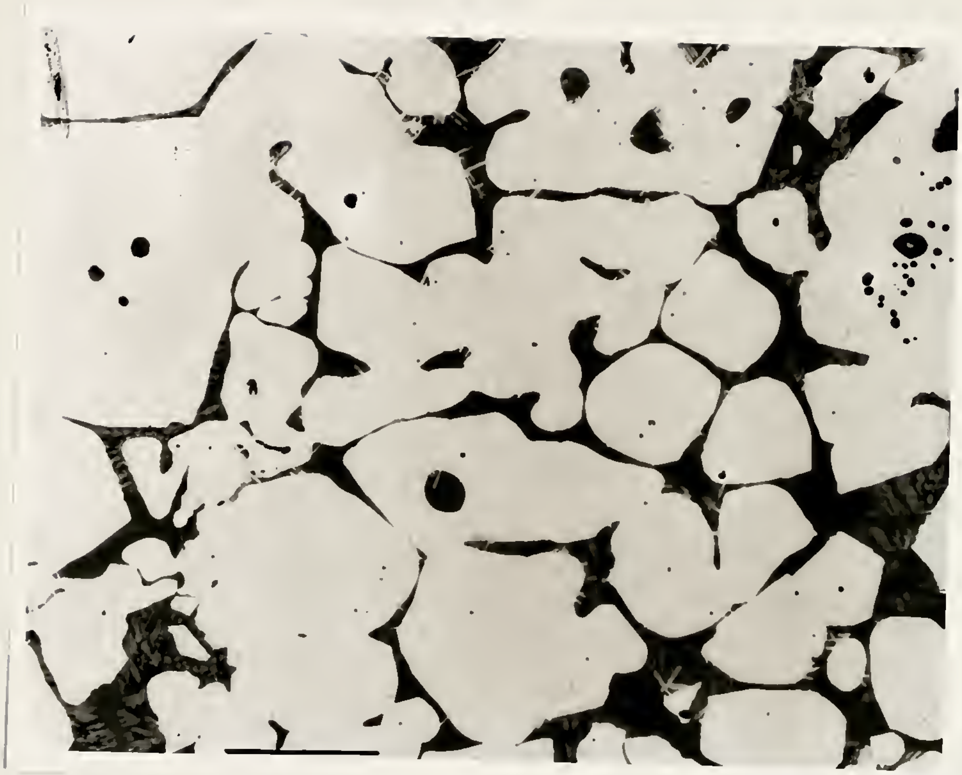

Fig. 7.6 Photomicrograph of a slag sample, lab # 160-2, showing large grains of wustite (bright, round particles) as the dominant phase. Other phases include fayalite (light-gray lathes) and glass (dark-gray areas). Black areas are pores. (Scale is 100 μm). X200

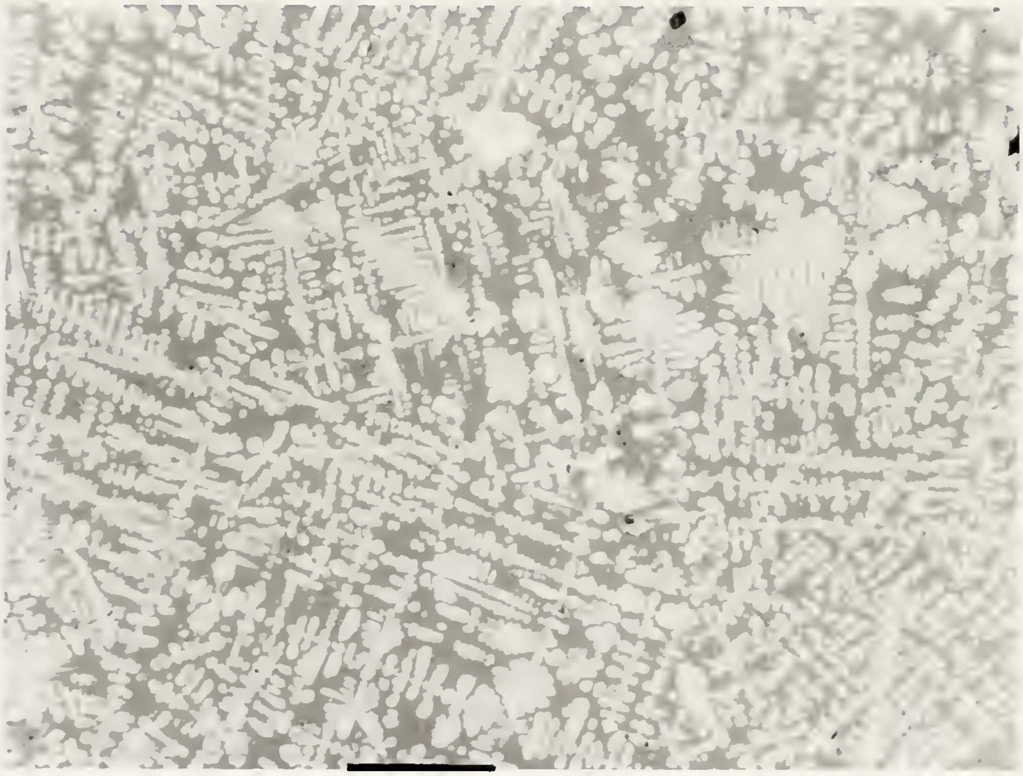

Fig. 7.7 Photomicrograph of a slag sample, lab # 157-1, showing small dendrites of wustite in a fayalite phase. (Scale is 100 μm). X200.

3. <u>To determine whether blooms in the katukutu furnaces were left to cool inside the furnaces or were raked out soon after smelting</u>

We know that all <u>malungu</u> furnaces had <u>palinyina</u>, a wider opening used when raking out bloom, slag, and other materials from the furnace. According to former iron smelters, bloom raking took place about 12-24 hours after the smelting stopped. At this time the bloom was cold enough to be touched with bare hands. We also know that Barongo furnaces were dismantled soon after smelting. The furnace was then left for about 12 hours to cool before the bloom was dug out of the ash and furnace slabs (de Rosemond 1943; Schmidt in press). The <u>katukutu</u> furnaces had <u>palinyina</u> and they were reused in a similar manner to the <u>malungu</u> furnaces (but without slag tapping mechanism). However, we do not know whether the <u>katukutu</u> blooms and slag were extracted immediately after smelting stopped or were left to cool inside the furnaces.

<u>Metallographic indices.</u> Materials (bloom and slag) that are left to cool inside the furnace tend to have larger grains than those suddenly exposed to the atmosphere when still hot by raking them out, opening the furnace doors, or dismantling the furnaces. Because the temperature inside the furnace cools slowly, the microstructure of the materials inside the furnace has enough time to grow. When hot materials come into contact with the atmosphere which, often times is fifty times or more cooler than the furnace interior (Schmidt and Avery 1979; van der Merwe and Avery 1982; Friede <u>et al</u>. 1984), they cool very quickly so that the crystals do not form completely or grow

large. As a result, silicate-based materials become glass (uncrystallized materials) and metallic materials form small grains.

Differential oxidation or carburization in the bloom also helps to reconstruct the environment in which given materials cooled. Raking a hot bloom out of the furnace exposes it to the oxygen-rich atmosphere resulting in a continuous decarburized (low carbon content, 0-0.2%) zone around the surface. Similarly, the presence of both magnetite and hematite crystals in the adhering slag is a further indication of cooling in an oxidizing atmosphere (Killick 1990).

Analysis and findings. Since all of the bloom samples were severely corroded on the outside, differential oxidation could not be determined. The cooling rate was therefore comparatively established based on only the variability in grain sizes between samples. Fourteen samples were analyzed metallographically. These included seven items excavated outside furnaces and another seven excavated from inside the furnace (believed to have cooled inside the furnace). The materials from each group included one wall dripping slag (type C-n); one dense, flow slag (type B-n); three metallic slag (type B-m); one bloom, and one partially reduced ore (PRO) (Tables 7.1a and b). In order to attain a standard result, the grain-size measurement was limited to the two most common phases, wustite (FeO) and fayalite (Fe_2SiO_4).

Photomicrographs of six samples were taken at X200 magnification using the Energy Dispersal Spectroscope. These

have a 100 microns (μm) scale. This scale was then used to measure micro-grains in photomicrographs taken at the same magnification (X200) but without a scale. The results (average sizes) are presented in tables 7.1a and 7.1b. Wustite measurements are given by diameter because the grains are often round in shape, whereas fayalite measurements are given by width because fayalite often appears as rectangular lathes.

Table 7.1a: Samples excavated outside the furnaces

Lab #	Site and Furnace #	Type of Material	Result (μm) Wustite	Fayalite
084-1	Hvlk-1, F1	B-n slag	20	10
193-1	Hvlk-17, F2	B-m slag	60	20
160-1	Hvlk-25, F7	B-m slag	90	10
160-2	Hvlk-25, F7	B-m slag	100	80
160-3	Hvlk-25, F7	C-n slag	30	20
144-1	Hvlk-25, F6	bloom	70	- -
144-2	Hvlk-25, F6	PRO	30	- -
		Total	400	140
		Average	57	28

Table 7.1b: Samples excavated inside the furnaces

Lab #	Site and Furnace #	Type of Material	Result (μm) Wustite	Fayalite
157-1	Hvlk-25, F6	B-n slag	10	4
158-2	Hvlk-25, F6	B-m slag	90	20
158-3	Hvlk-25, F6	B-m slag	--	10
159-1	Hvlk-25, F6	B-m slag	110	50
095-1	Hvlk-1, F3	C-n slag	40	30
157-2	Hvlk-25, F6	bloom	15	10
259-1	Ialm-1, F32	PRO	40	- -
		Total	305	124
		Average	50.83	20.67

Conclusion. The statistical analysis presented in tables 7.1a and 7.1b show that there is no significant difference in grain size between the materials excavated outside the furnace and those excavated inside the furnace. This means that both materials experienced a similar cooling rate. Most materials, however, have large and rounded grains (e.g., Fig. 7.6) which indicates that the materials cooled inside the furnace (see also the bloom, Fig. 7.4). The variation in grain sizes between samples is attributed to thermal and chemical heterogeneity common in pre-industrial bloomery furnaces (Avery and Schmidt 1979; van der Merwe and Avery 1982; David et al. 1989).

The fact that there are some samples with exceptionally small grains such as 157-1 (Fig. 7.7) indicates that some of the materials were raked out when they were still hot. That is to say, the smelters did not wait until the temperature inside the furnace were at equilibrium with the temperature outside the furnace before they raked the bloom and other materials out. Based on the ethnographic information of the cooling rate of the malungu and Barongo furnaces we can estimate that bloom raking in the katukutu furnaces (which are smaller than the other two types) took place between 6 and 12 hours after smelting.

4. Technological efficiency: a comparative analysis

Efficiency of a bloomery process is generally estimated by assessing the amount of metallic iron and free iron oxides

(wustite and magnetite) found in the slag (Morton and Wingrove 1972; Rostoker and Bronson 1990; Killick 1990). An iron-rich slag is recognized in the field by its density, magnetism, and would often show oxidation marks (reddish or yellowish coloration) on the surface. However, metallographic analysis is more helpful in this case because it reveals the phases present and their relative amounts can be quantified.

Metallographic Indices: The presence of metallic iron and a high percentage of free iron oxides, especially wustite (FeO) and magnetite (Fe_3O_4) in the slag, indicate an inefficient reduction technique, whereas slag with a small amount of the iron oxide phases indicates that the reduction technique was efficient. It should be remembered that slag is a variable material. A single smelt, for example, can produce all slag types and sub-types listed in chapter 5. The validity and accuracy of this index, therefore, depends on the sampling strategy employed. In comparing slag in space and time one needs to take into consideration slag types and sub-types shown in chapter 5. For example, a stratified sampling strategy needs to be employed to ensure a balance between metallic ("m" sub-types) and non-metallic ("n" sub-types) slag in dealing with a question of technological efficiency.

Analysis and Findings. A total of twenty-eight pieces of smelting slag from all three technological types (katukutu, malungu, and Barongo) were analyzed for this question (Tables 7.2, 7.3 and 7.4). Only type B slag pieces were used in this exercise: ten samples from each of the katukutu and the

malungu technologies and eight from the Barongo-type technology. This type (B) was selected because it is found in all three technological types. Furthermore, an equal number of the metallic (B-m) and non-metallic (B-n) samples was selected from each technological type in order to ensure a balanced comparison of the three technologies. For the same reason only the first three dominant phases found in each sample were used in computing an inefficiency percentage of the three technologies. The phases are presented in the tables in decreasing order by quantity. This is based on visual estimation as opposed to precise measurements for instance by point counting.

Table 7.2 Dominant Microconstituents in the Slag from the Katukutu Type of Technology

Ser. #	Lab #	Provenance	Slag Type	Dominant Phases
1	084-1	Hvlk-1	B-n	fayalite, glass, wustite
2	255-1	Ialm-1	B-n	fayalite, glass, hercynite
3	259-1	Ialm-1	B-n	fayalite, glass, hercynite
4	157-1	Hvlk-25	B-n	wustite, fayalite, glass
5	159-2	Hvlk-25	B-n	magnetite, fayalite, glass
6	193-1	Hvlk-17	B-m	wustite, fayalite, iron
7	158-2	Hvlk-25	B-m	wustite, fayalite, glass
8	159-1	Hvlk-25	B-m	wustite, iron, glass
9	160-1	Hvlk-25	B-m	wustite, iron, fayalite
10	160-2	Hvlk-25	B-m	wustite, glass, fayalite

Table 7.3 Dominant Microconstituents in the Slag from the Malungu Type of Technology

Ser. #	Lab #	Provenance	Slag Type	Dominant Phases
1	238-1	Hvlk-39	B-n	fayalite, glass, wustite
2	238-2	Hvlk-39	B-n	wustite, glass, fayalite
3	218-1	Hxlo-2	B-n	wustite, fayalite, glass
4	220-2	Hxlo-2	B-n	fayalite, glass, hercynite
5	217-2	Hxlo-2	B-n	fayalite, glass, iron
6	238-3	Hvlk-39	B-m	fayalite, glass, wustite
7	218-2	Hxlo-2	B-m	fayalite, glass, iron
8	219-2	Hxlo-2	B-m	fayalite, glass, hercynite
9	220-1	Hxlo-2	B-m	iron, glass, fayalite
10	266-1	Ialm-4	B-m	wustite, hercynite, fayal.

Table 7.4 Dominant Microconstituents in the Slag from the 'Barongo' Type of Technology

Ser. #	Lab #	Provenance	Slag Type	Dominant Phases
1	132-1	Hvlk-35	B-n	wustite, fayalite, glass
2	132-2	Hvlk-35	B-n	hercynite, fayalite, glass
3	142-1	Hvlk-60	B-n	magnetite, fayalite, glass
4	142-2	Hvlk-60	B-n	wustite, glass, magnetite
5	132-3	Hvlk-35	B-m	hercynite, fayalite, glass
6	132-4	Hvlk-35	B-m	wustite, hercynite, fayal.
7	132-5	Hvlk-35	B-m	magnetite, fayalite, glass
8	044-1	Hvlk-36	B-m	wustite, fayalite, glass

The level of inefficiency of each technology was measured as percentages. This was done by multiplying the summation of events (e), that is, occurrences of metallic iron and iron oxides (wustite and magnetite) in a given technology (underlined in the tables) by 100. The result was divided by the product of the total number of samples per technology (n) and the number of

phases sought (Y), in this case three (3), namely metallic iron, wustite, and magnetite. The formula can be abbreviated as:

$$\frac{\sum e(100)}{nY}$$

Where e = events (actual occurrences of the elements that are sought in a given sample).

n = number of samples analyzed.

Y = number of elements sought. In this case three, namely, metallic iron, wustite, and magnetite.

In katukutu samples a total of eleven events ($\sum e=11$) were recorded in the ten samples (underlined phases in Table 7.2). The percentage of inefficiency was then computed as follows:

$$\frac{\sum e(100)}{nY} = \frac{11 \times 100}{10 \times 3} = \frac{1100}{30} = 36.67\%.$$

Eight events ($\sum e=8$) were recorded in the ten malungu slag samples (underlined phases in Table 7.3). The percentage of inefficiency for this amount is as follows:

$$\frac{\sum e(100)}{nY} = \frac{8 \times 100}{10 \times 3} = \frac{800}{30} = 26.67\%.$$

Seven events ($\sum e=7$) were recorded in the eight Barongo-type slag samples (underlined phases in Table 7.4). When the percentage of inefficiency was computed, the following result was obtained:

$$\frac{\sum e(100)}{nY} = \frac{7 \times 100}{8 \times 3} = \frac{700}{24} = 29.16\%.$$

Conclusion. The study shows that the katukutu technology, with 36.67% of metallic iron and iron oxides in its slag, is the

least efficient or most wasteful technology in the research area. This is followed by the Barongo-type technology with 29.16% of iron and iron oxide. The malungu technology, with 26.67% of the three elements, is the most efficient of the three technologies within the boundaries of the sampling program.

5. To account for the paucity of slag in the katukutu technology

Slag are the most ubiquitous of all the materials that are related to iron smelting and metallurgy in general. As Bachmann notes, "in almost every survey or excavation, the field archaeologist will encounter finds which he [or she] may tentatively label 'slag' or 'vitrified materials'" (Bachmann 1982:1). The quantity (number, volume and weight) of slag in archaeological sites varies depending on factors such as furnace size, number of smelts performed, the type of ore used, and the type and amount of fluxing materials applied. In his archaeological survey in central Malawi Killick (1990) found 35 smelting sites with slag heaps ranging in volume from 0.1 cubic meter to 30.5 cubic meters. In terms of weight, Killick observed that the median size of slag heap was between three and five metric tonnes and the largest slag heap measured about 42 metric tonnes[2]. The largest reported smelting site in southern Africa has seven standing furnaces and an estimated

[2] This was three to four times smaller than several other slag heaps he casually observed while collecting oral traditions in central Malawi in 1983 (Killick 1990:166).

180 metric tonnes of slag (van der Merwe and Killick 1979 quoted in Killick 1990).

The largest katukutu site in terms of the number of associated smelting furnaces recorded in the current field research is Hvlk-25 with 14 furnace remnants. A surface investigation on the site, a 50X50 m area, yielded no slag at all. And when 3992 cubic cm of soil were excavated, only 436 pieces of slag, weighing 3.369 kg, were recovered (for details see chapter 6). This contrasts significantly with the observations by Killick (1990) as well as van der Merwe and Killick (1979, quoted in Killick 1990), but also with the malungu and Barongo-type sites found in the same region (southwestern Tanzania). For example, the largest number of smelting furnaces of the malungu type recorded at one site in the current field research is Hxlo-5 in Kalundi. This site had 12 furnaces, each with a heap of slag measuring between 20,000 and 30,000 cubic cm. Excavation of 800 cubic cm inside a furnace at site Hxlo-2 yielded 6.92 kg of slag. When this is compared with 11.28 kg of slag from 12,255 cubic cm of excavated soil in all five katukutu sites that were excavated (Table 7.3) the difference is astonishing, and points to an impoverishment of slag at the katukutu sites.

Why do the katukutu sites have such a small amount of slag? Several hypotheses may be considered. These include: 1) slag was lost later through reuse by traditional healers; 2) trans-technological slag re-use, namely the iron smelters of the Barongo-type technology collected and re-smelted the katukutu

slag as they did their own slag; and 3) the <u>katukutu</u> was, uniquely, a technology producing low volumes of slag.

The first hypothesis cannot be tested by laboratory techniques. It is discussed in chapter 8. We should, perhaps, note here that local people in the research area (as in other parts of Africa [Van der Merwe and Avery 1987; Schmidt in press]) strongly associate iron smelting with human reproduction. Local healers, for example, use iron slag as <u>kizimba</u> (a central ingredient in medicine) to treat infertility. However, only a small amount is used for this purpose. A typical healer would have in their possession between 0.5 and 1 kg of slag, an amount that can last for a year. The other two hypotheses can be tested, in varying degrees, by laboratory techniques. The following discussion presents the analytical procedures and the results.

<u>Trans-technological re-use of slag by the Barongo-type smelters.</u> Slag re-smelting was a common practice among ancient metallurgists (Schmidt and Childs 1985; Kense 1985: Killick 1990). This was done in order to extract iron prills entrapped in the slag (in which case metallic slag was often targeted) or to flux the operating smelt (in which case any slag type was used) (Killick 1990). Slag that was re-smelted could come either from the same furnace (or site) or from another furnace far away from the furnace using the old slag. In either case slag could come from the same technology or a different technology. Quantitative and qualitative (chemical) effects in slag would be more noticeable when the transfer of slag was

between different technologies and would be less conspicuous when the transfer was within the same technology or furnace. Using slag from another site or technology reduced the amount of slag in the donor site and possibly introduced new elements (especially if the two sites used different iron ores or ore sources) to the receiving site. This impact is what we are trying to understand here.

We noted in chapter 3 that Barongo iron smelters of southern Lake Victoria region, northwestern Tanzania, used old slag with fresh iron ore whenever they smelted. This research project identified three smelting sites of the Barongo-type and all of them were located less than two km from the nearest katukutu sites. One of these sites, Hvlk-35, has been radiocarbon dated to 20 ± 50 BP (with 95% accuracy). When this date is cross-checked with oral accounts we find that the site was likely occupied in the late nineteenth century (see chapter 6). The katukutu sites on the other hand date between 100 ± 70 and 430 ± 70 BP (with 95% accuracy; see chapter 6 and table 8.1). This chronological sequence suggests that the "Barongo" iron smelters southeastern Lake Tanganyika region could have used the slag left by the katukutu smelters over 100 years before them. Moreover, we noted in problem No. 4 above that katukutu slag contains the highest amount of iron as compared to slag from the other technologies. The high iron content might have been an additional factor that attracted the "Barongo" smelters to re-smelt katukutu slag.

Laboratory indices. Elemental comparison is the best index for determining the possibility of trans-technological slag re-use. If all or most chemical elements found in the slag from the donor technology (in this case katukutu) are also found in the slag of the receiver technology (in this case Barongo-type) then there is a great possibility that trans-technological slag re-use was practiced. But if the slag differ significantly in elements, then the likelihood of trans-technological slag re-use is small or absent.

Analysis and results. Six samples were analyzed for chemical identification in regards to this problem. All samples were taken from Kirando where Barongo-type sites are found. Four samples, including one piece of slag, two blooms, and a piece of vitrified furnace wall came from two different katukutu sites, Hvlk-17 and Hvlk-25. Two samples of slag, each came from a different Barongo-type site, Hvlk-35, and Hvlk-36.

Three of the findings are presented in figures 7.1, 2 and 4, and the remaining can be found in appendix C. All the katukutu samples together consisted of the following ten elements: iron (Fe), silica (Si), aluminum (Al), calcium (Ca), oxygen (O), phosphorous (P) potassium (K), titanium (Ti), manganese (Mn), chlorine (Cl), and zirconium (Zr). Each individual sample missed one or two of these elements. For example, figure 7.1 does not have zirconium, while figure 7.2 misses phosphorus and zirconium. The Barongo-type samples had all elements found in the katukutu samples except manganese (Mn) (Fig. 7.8), instead,

there was magnesium (Mg) (see sample 044-1 in appendix C) which was missing in the katukutu samples.

Conclusion. The elemental analysis show a significant similarity between the two technologies which, in turn, suggests that there may have been a trans-technological slag re-use by the Barongo-type iron smelters. We have also noted some variations of one-to-two elements within and between the technologies. These variations are insignificant because the elements involved appear in very small quantities. However, given the small sample size used in this study this conclusion should be regarded as tentative; a large sample size is needed.

Fig. 7.8 Elemental analysis of a Barongo-type slag, sample 132-2, type B-n (flow, dense) slag from site Hvlk-35, Unit 2, Block 1, Level A: 00-20 cm below datum point.

Low-slag generating technology. Two hypotheses have been discussed to this point: medicine and trans-technological slag re-use. It has been demonstrated that each of these was a valid factor for the paucity of slag in the katukutu technology. But to attribute the paucity to these factors alone would be to overstate the point. It is therefore more likely that the major cause of the paucity of slag is to be found in the technology itself. Unfortunately, this hypothesis was not seriously addressed in the field because, from the preliminary assessment of the other two hypotheses, I was convinced that they would offer a satisfactory explanation. Further research is needed which will focus on the chemistry of the ore and the refractory materials (furnaces and tuyeres), as well as thermodynamics involved in smelting process. This calls for experimental smelting. I hope that through such studies we will understand better the reason why so little slag was produced in the katukutu furnaces.

6. Metals: whether indigenous or imported (industrial).

Iron artifacts are important cultural evidence because they not only provide proof of iron production but also reveal the function to which iron was put. Tools and weapons such as hoes, spears, arrow, axes, knives, hooks, hammers, and pincers provide a wide range of information including farming, hunting, fishing, smithing and social expression (ritual, decoration,

regalia, etc.). In most parts of sub-Saharan Africa iron artifacts are difficult to find in the archaeological record because of the acidic soils and the humid conditions which facilitate corrosion of the metal (Clark 1974). In this field research, for example, only two iron artifacts were recovered in excavation: a piece of a hoe (Fig. 7.9a) from site Hvlk-35 and a nail (Fig. 7.9b) from site Hvlk-58.

Iron artifacts are sometimes traded across large geographical regions and for that reason we cannot take them as ipso facto proof of iron smelting as we do with furnaces and in situ heaps of tuyeres and smelting slag. The Periplus of the Erythraean Sea (Casson 1989), for example, points out that the coast of East Africa imported iron from the Persian Gulf as early as the first century A.D. It should be remembered that Arabian iron was imported despite the fact that local iron was being produced in the Indian Ocean littoral (Chami 1988, 1994; Schmidt et al. 1992). We also know that during the Portuguese trading era (15th-18th centuries) in eastern and southern Africa iron became a medium of exchange (Theal 1964). Portuguese and Swahili traders were using iron nails to purchase various local products both along the Indian Ocean littoral and the interior (Theal 1964). As Manuel de Mesquita Perestrello, a shipwreck victim along southeastern Africa, remarks:

> seeing that ... the wounded were sufficiently recovered to start [our journey], ... each one filled his wallet with what provisions he could and as much nails and iron as he could carry to trade with, for at that time these things

were esteemed as the most precious jewels (Theal 1964:226).

In chapter 6 we noted that European ironware became increasingly popular along the shores of Lake Tanganyika, including Kirando and Kala (research localities along the shore), following the intensification of trade connections along the lake by the turn of the last century. The fact that imported (European) iron was used in the research area in addition to local iron in recent historic times prompts the need to determine whether the metal artifacts found during the research project were made from imported or locally manufactured iron.

Metallographic indices. Iron produced in the research area (southwestern Tanzania) can be distinguished from European iron by using criteria similar to those used in problem No. 2 to distinguish bloomery from indigenous and modern blast processes. Industrial iron is more homogeneous in structure and in composition than pre-industrial bloomery iron because the smelting environment of the former is more controlled. Additionally, chemicals are applied in industrial smelts to eliminate or minimize unwanted elements. The amount and variation of inclusions, such as slag and nonferrous elements, are lower in industrial iron compared with locally processed bloomery iron. Finally, if industrial iron contains slag, then the dominant phase will be fayalite (Fe_2SiO_4) rather than wustite (FeO). This is because both the high temperature and the controlled amount of oxygen in the blast furnaces enable the

iron-rich wustite to reduce and give out more metal (Samuels 1980).

All three iron technologies (katukutu, malungu, and Barongo-type) found during this research project used a bloomery process.

Analysis and findings. Metallographic analysis was conducted on all three iron objects obtained in this research project.

Sample 129-1. This was a piece of hoe (Fig. 7.9a) excavated at site Hvlk-35, 8 cm below the datum point. The site has been radiocarbon dated to 20 $\pm$ 50 B.P., verified by oral traditions to the late nineteenth century A.D. A small sample piece (12X4 mm) was removed from one corner of the cutting edge of the hoe (Fig. 7.9a). The sample was analyzed for microconstituents both before and after etching. The results showed that the hoe had been made from a low-carbon steel. The main microconstituent, the metallic iron, consisted of ferrite and pearlite (alternate lamellae of cementite and ferrite) (Fig. 7.10). Slag stringers were also found. These consisted of wustite (the dominant phase), anorthite ($CaAl_2Si_2O_8$), and glass.

Conclusion. The presence of multiple phases of slag and the dominance of wustite in the slag indicate that the steel with which the hoe was made came from an indigenous bloomery process.

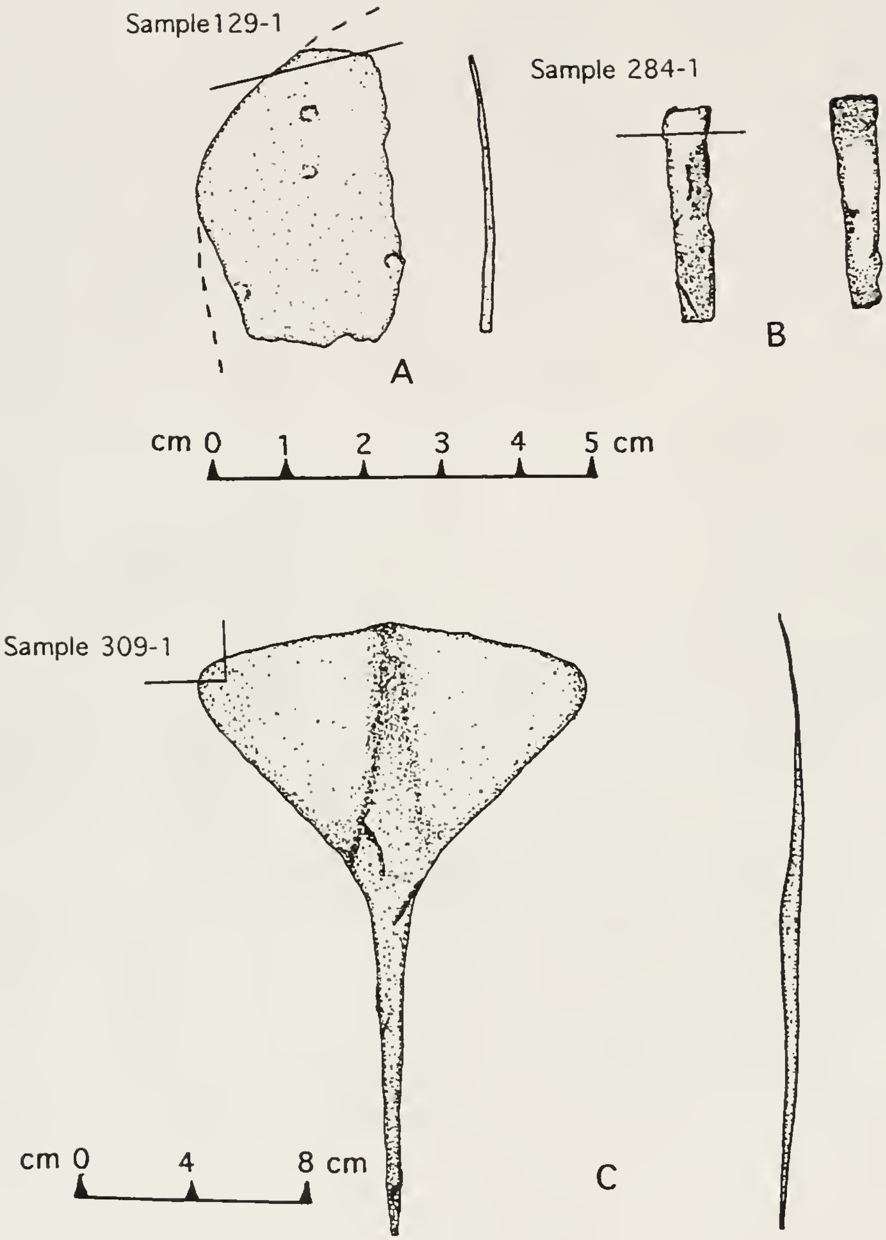

Fig. 7.9 (a) A piece of a hoe excavated from site Hvlk-35, Kirando. (b) A nail excavated from site Hvlk-58, Kirando. (c) Remnant of a Fipa "male hoe" (<u>ise</u>) made from local iron. It was obtained from Mzee Xavery Mwanakatwe, a former iron worker in Kalundi, Fipa plateau.

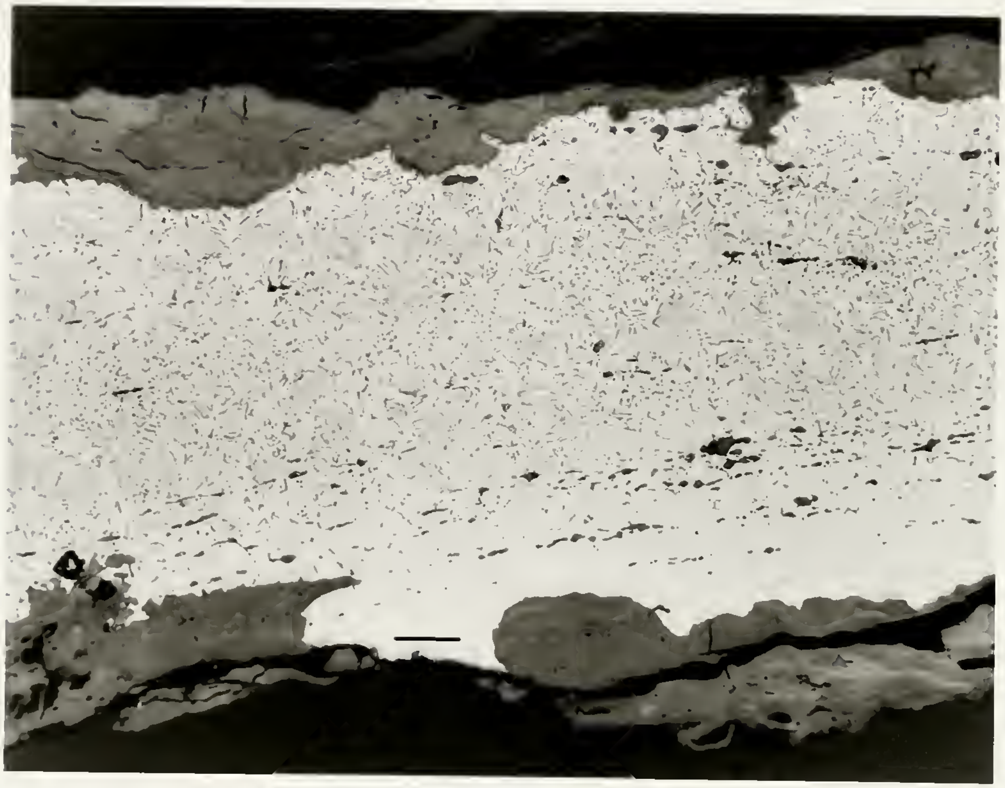

Fig. 7.10 Photomicrograph of an iron hoe, lab # 129-1, from site Hvlk-35, Kirando, showing ferrite (white grains) and pearlite (dark grains). (Etched with 2% nital, 3 seconds; scale is 100 μm). X100.

Sample 284-1. This is an iron nail excavated from site Hvlk-58, Unit 3, 20-30 cm below datum. The metal was found in association with TIW (Triangular Incised Ware) pottery and a piece of charcoal that has been dated with 95% accuracy to 1040 $\pm$ 80 B.P. (910 $\pm$ 80 A.D.). The nail measured 31 mm in length and 6 mm in average diameter. Both ends were blunt, but one was thicker than the other by two millimeters (Fig. 7.9b). The surface was highly corroded; only 4 mm of the core metal was left.

A transverse section cut from the thickened tip was processed and analyzed before and after etching. The results showed that the nail was made from a low-carbon steel composed of ferrite and fine pearlite (Fig. 7.11). Slag was also found. It consisted of wustite and glass.

Conclusion. The presence of multiple phases of slag and wustite as the dominant phase indicate that the steel was produced locally using a bloomery process.

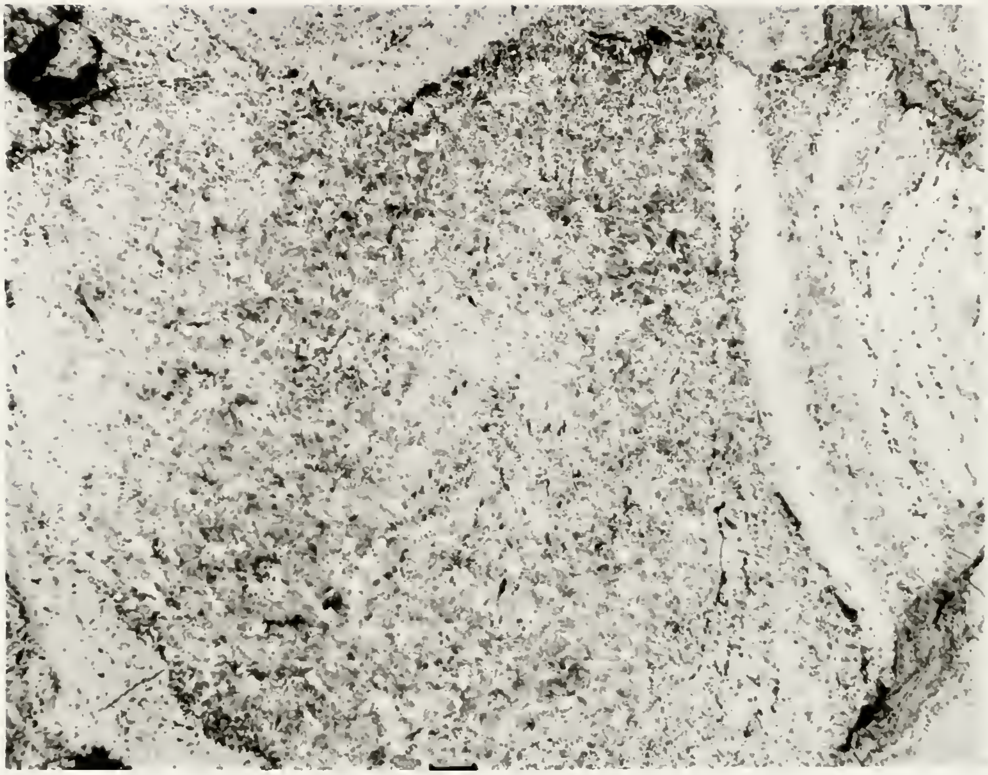

Fig. 7.11 Photomicrograph of an iron nail, lab # 284-1, from site HvIk-58, Kirando, showing ferrite (white grains), fine pearlite (dark grains) and slag inclusions dominated with wustite (the light phase) and glass (dark-gray). (Etched with 2% nital, 3 seconds; scale is 100 μm). X50.

Sample 309-1. This is a remnant of a Fipa "male hoe" (Fig. 7.9c), called ise in Kifipa, obtained from one informant who kept it as an heirloom. Aside from understanding the forging techniques, this sample was analyzed in order to verify the claim that it was a product of local ironworking.

A sample was taken from one corner of the cutting edge (Fig. 7.9c). Phase identification was conducted both before and after etching. It was found that the hoe was made from wrought iron (ferrite) (Fig. 7.12). Slag stringers were also found. These consisted of wustite and glass located in the metal matrix as well as oxide scales (residue from pre-welding processes) located along the weld seams (Fig. 7.12).

Conclusion. The presence of wrought iron, multiple phases of slag, and wustite as the dominant phase indicate that the hoe was produced from a bloomery iron.

Finally, it should be noted that although we have been able to establish that all three artifacts are products of bloomery processes and therefore are not European products, there are two problems associated with this question that we cannot solve metallographically. We can neither tell the type of technology which produced them (katukutu, malungu, Barongo-type, or any other technology) nor accurately pinpoint the area of origin, such as a site or village. This is because the bloomery process was used in many places in Africa as well as outside the continent. Additionally, "there are no generally applicable scientific techniques that can distinguish between bloomery iron from different regions -- nor is it likely that this will ever

be possible, given the ubiquity of iron ores" (Killick and Makokha n.d:3).

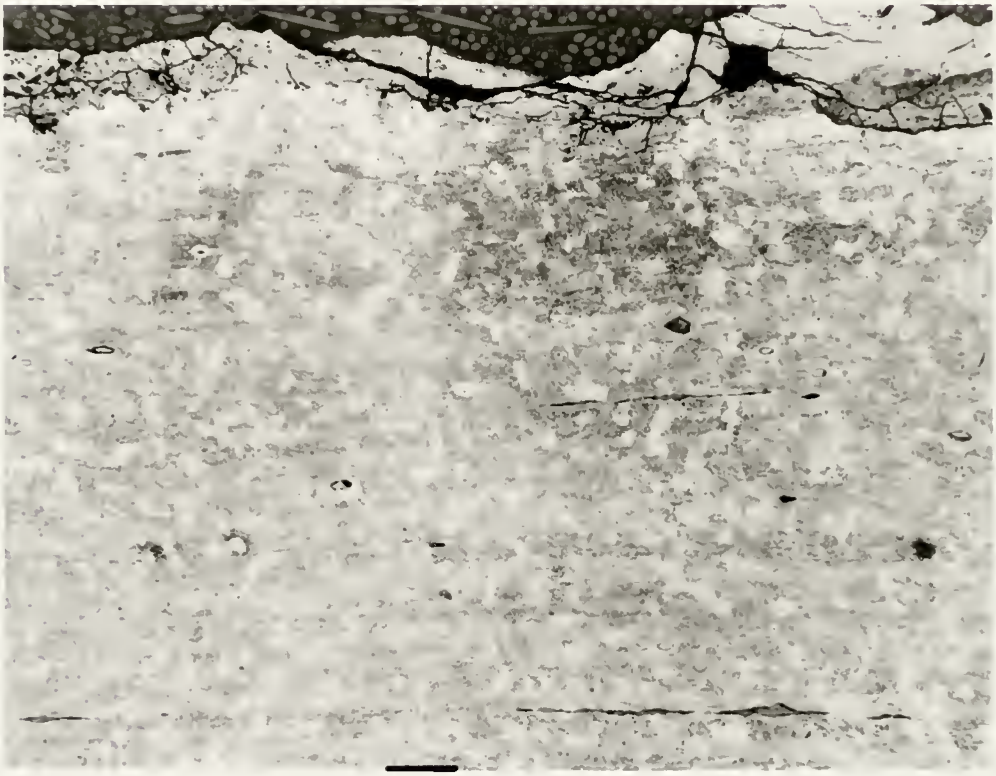

Fig. 7.12 Photomicrograph of an ethnographic iron hoe, lab # 309-1, from Kalundi, Fipa plateau, consisting of almost pure ferrite. Slag inclusions are also found. (Etched with 2% nital, 3 seconds; scale is 100 μm). X100.

7. Forging Techniques

There are several forging techniques that one can understand by observing a polished sample of carbon steel under the microscope. These include welding, folding, quenching, annealing, cold working, hot working, carburization, decarburization, etc. The following are common indices that can be used to determine if any of such techniques was intentionally applied in fabricating an artifact.

Welding (joining two metals by heat treatment with no solder applied [Scott 1991]). It is indicated in metallography by the presence of seams often marked by slag stringers, gas bubbles, and sometimes oxide scale as in figure 7.12. Since the welded metals are often different, the microstructures across the welding seams will most often differ in composition, grain size, degree of carburization, and orientation of grains and slag stringers.

Folding. This is indicated by a seam similar to that of welding except that the bordering metals will be similar in microstructure because the enfacing metals belong to the same sheet which was bent over upon itself in U-form and hammered together to join them.

Cold working (deformation of a metal below the recrystallization temperature (Askeland 1989)). The grains are deformed, and often become elongated due to hammering. The intensity of the deformation decreases towards the center of the object. Cracks may also occur. Cold worked joints are more

conspicuous and often without crystals growing across them (seams).

Annealing (a heat treatment which involves austenitizing (heating steel to temperatures below 727° C) then furnace cooling (cool slowly). It is used to eliminate the effects of cold working): Annealed steels are soft and usually have coarse-grained pearlite.

Hot working (deformation of a metal above the recrystallization temperature (Askeland 1989)). Crystals can grow across the weld seams. Fold and weld seams are marked more often by carbon banding than by slag stringers. Cracks are not common because the ductility of steel (and many other materials) increases with the increase of temperature (Askeland 1989).

Quenching (quickly cooling a metal or alloy by plunging it into cold water or another liquid). The most common product of quenched steel is martensite, an acicular or lath constituent formed by a diffusionless (the parent and product phases have no compositional differences), homogeneous process (Petty 1970).

Tempering (a low-temperature heat treatment used to reduce the hardness of martensite by allowing it to decompose to the equilibrium phases e.g., of ferrite and cementite (Askeland 1989)). If steel is tempered below the eutectoid temperature, which is about 727° C, spheroidite forms. It consists of a continuous phase of ferrite and round (spheroidised) grains of cementite.

Carburization (diffusion of carbon into a steel for surface hardening). This is identified by carbon banding (differential distribution of carbon), whereby the exterior contains more carbon than the interior. Fabricators sometimes carburize cutting or piercing edges of tools and weapons to harden them. Such objects have a higher carbon content (the etched surface will appear darker) along the edges than the rest of the body.

Decarburization (elimination of carbon from steel or cast iron to enhance malleability). This is indicated by differential distribution of carbon, whereby the exterior has less carbon than the interior.

Analysis and Findings. The three samples (129-1, 284-1, and 309-1) described and analyzed under problem # 6 above were also analyzed to shed light on what forging techniques was applied to the metal.

Sample 129-1. The polished section showed three seams (Fig. 7.13). The microstructure was the same at any opposite points across the seams. This indicates that the same metal sheet was folded and welded twice. The growth of crystals across the seams as observed in figure 7.10 shows that hot welding was involved, or the material was annealed to a recrystallization temperature.

Fig. 7.13 Photomicrograph of an iron hoe, lab # 129-1, from site Hvlk-35, Kirando, showing weld lines. (Unetched; scale is 100 μm). X100.

The presence of ferrite and pearlite and the absence of martensite and spheroidite indicates that the metal was not quenched after it was manufactured. There are indications,

however, that the hoe was annealed. This is shown by the decrease of grain size and the increase of carbon towards the center. Decarburization is a common process on the surface of any steel that is austenitized under conditions that form an oxide scale. As Samuels notes, the carbon at the metal surface oxidizes to form the gases carbon monoxide and carbon dioxide. These escape to the atmosphere because the oxide scale is permeable to these gases (Samuels 1980).

Since this was a cutting object and because the carbon content of the metal is generally low, the evidence of decarburization found on the surface seems to have been accidental rather than intentional. This occurs when forging takes place in an open hearth--a practice that was also observed during this research project among the present day iron smiths.

It seems that after it was manufactured the hoe was left to cool in the air. This resulted in decarburization and the formation of grains probably smaller than those observed in the center of figure 7.10. The hoe was then annealed in an open hearth where the carbon continued to burn out and the surface grains grew. The annealing period was not long enough to bring about homogeneity in grain size, and the decarburization. This resulted in the development of the different grain sizes and the carbon banding observed on the metal (Fig.7.9b).

Sample 284-1. Figure 7.11 shows two regions with varying carbon content and aerial size. The first region is

extensive and has a higher carbon content consisting of pearlite of uniform grain size. There are also curved slag stringers in this region suggesting that the metal was rolled at least once. The second region has a lower carbon content than the first one and consists of alternating curved layers of ferrite and pearlite which probably resulted from welding of wrought iron and steel. The layers are facing a different direction (Fig. 7.11) from the slag stringers of the first (extensive and homogeneous) steel. It is not possible, however, to establish the cause of the "disorientation" of the lamellae because of the severe corrosion on the outside of the sample.

Sample 309-1. Two weld seams are evident in this sample (Fig. 7.14). The grains are similar in structure at any opposite points across the weld lines suggesting that the hoe was made from one sheet of wrought iron that was folded and welded twice. The presence of remnants of oxide scale along the weld seams is an indication of poor welding ability by the fabricators.

Schrader and Rose (1966:24) note that "in the microstructure of low-carbon, hot worked and annealed steel, ferrite forms as polygonal grains of irregular shape and different sizes". Thus, the presence of uniform, coarse, polygonal grains indicates that the hoe was not quenched after forging, but annealed. Since the metal is low in carbon, we can infer that both forging and annealing took place in an oxidizing

environment (open hearth). The annealing period was long enough to bring about homogeneity in grain size.

Fig. 7.14 Photomicrograph of an ethnographic iron hoe, lab # 309-1, from Kalundi, Fipa plateau, showing weld lines. (Unetched; scale is 100 μm). X50.

<u>Conclusion.</u> From the foregoing analysis we learn that only a few of the common smithing techniques are not evident in the artifacts found from southwestern Tanzania. These include quenching, tempering, and carburization. While the absence of these techniques may be a function of the small sample number (3) analyzed, it is interesting to learn that the results of this analysis parallels a general picture of smithing techniques common in Africa. For example, van der Merwe also notes that "the laborious procedures of carburization, quenching, and tempering, which form such essential components of the European and Near Eastern traditions, were rarely applied in Africa in a systematic way" (van der Merwe 1980:486). The reason for this difference is, very likely, technical rather than ignorance. As van der Merwe rightly argues, carburization, quenching and tempering "should probably be seen as necessary elaborations of a process which yields low carbon iron as the primary product and was consequently rendered unnecessary by the African shortcut to high carbon steel" (van der Merwe 1980:486).

CHAPTER 8

SUMMARY AND CONCLUSIONS

The main goals of this research project were three fold as stated in chapter 1. First, I wanted to determine the archaeological potential of Nkansi District; second, establish the Iron Age culture history of that district; and third, examine the history and development of ironworking technology in that area. A broader perspective of evidence, including ethnographic, archaeological and archaeometallurgical pertaining to these objectives have been presented in the three preceding chapters (5, 6, and 7). In this chapter, I synthesize the evidence provided throughout this work in the light of these research goals, assess accomplishments and failures, and offer suggestions for future archaeological research in Nkansi District and southwestern Tanzania in general.

The Archaeological Potential of Nkansi District

Prior to this work, Nkansi District was archaeologically unexplored. Three research teams, however, worked in some

localities around this area. First, J. Desmond Clark led an intensive investigation at the Kalambo Falls, a multicomposite site located along the Tanzania-Zambia border to the south (Clark 1969, 1974). The excavations there produced the most complete and stratified sequence of culture history from an Acheulian Stone Age assemblage dating to more than 200,000 years ago, to the present day.

Second, Fagan and Yellen conducted excavations in the mid-1960s at Ivuna, a salt processing site located 15 km southwest of Lake Rukwa. The excavations there revealed two layers of cultural materials. The first was composed of potsherds, remains of humanly fractured animal bones, fish bone, a few pieces of slag, daub and hearths and was interpreted as a settlement level. The second was composed only of potsherds and was interpreted as a dumping level. This stratigraphic pattern indicated to the investigators that Ivuna was a multicomposite site used for salt extraction, probably during wetter periods, and for settlement during dry periods when the springs dried up. The site has been dated to between 1200 and 1400 A.D. (Fagan and Yellen 1968).

Last, Pamela Willoughby has been surveying for archaeological occurrences along the Lake Rukwa valley since the late 1980s. Her investigations have revealed archaeological materials ranging from the "Middle Stone Age" through the Iron Age (Willoughby 1990, 1991).

The current research project concentrated in Nkansi District (Fig. 1.1). The district consists of about 9,400 square

km of land mass divided into three physiographic regions: the Lake Tanganyika shore to the west, the Fipa escarpment in the middle, and the Fipa plateau to the east. Four different localities were sampled for intensive investigation (Survey and excavation). These included Kirando and Kala along the shore; King'ombe on the escarpment, and Kalundi on the plateau (Fig. 1.2). The archaeological investigation covered a total area of 97 square km: 84 km^2 at Kirando, 3 km^2 at Kala, 4 km^2 at King'ombe, and 6 km^2 at Kalundi. The investigations yielded seventy-five archaeological and historical sites: 60 around Kirando and five from each of the remaining localities (Kala, King'ombe, and Kalundi).

One site had "Later Stone Age" materials which included scrapers and burins. This was the only site with stone artifacts found in the entire research area. Sixty-three sites had evidence of ironworking such as furnaces, slag, tuyeres, iron ore, and charcoal; nine sites were marked with scatters of daub, potsherds (composed of Kalambo, TIW, Ivuna, Katukutu, and Kirando/Tabwa traditions) and animal bones (including domestic cattle, hippo and buffalo) suggesting that they had been used for residential purposes; and four sources of iron ore. Other sites included four ritual areas (used for exorcism and human sacrifice), one quarry of potting clay; and one ruined missionary compound (Fig. 4.1).

Nine ironworking sites and four habitation sites were excavated and seventeen samples of charcoal and charred wood from these sites have been dated (Table 6-22). The habitation

sites range in age from A.D. 900 to the present, and the ironworking sites vary from A.D. 1500 to the present.

Attribute and chemical analyses conducted on metallurgical materials reveal that at least three ironworking technologies, varying in space or time or both were present in Nkansi District. These included the katukutu technology dating to the sixteenth and eighteenth centuries A.D. and located along the shore and the escarpment; the malungu technology dating to the nineteenth and twentieth centuries and located mainly on the escarpment and the plateau; and the Barongo-type technology dating to the nineteenth century and located along the lake shore.

The findings from this investigation show that the archaeology of Nkansi District is biased towards the Later Iron Age (post-1500 A.D.). Pre-Iron Age materials are poorly represented. Although relatively large amounts of Early Iron Age pottery (Kalambo tradition) are found along the shore, the virtual absence of evidence for ironworking contemporary to the Kalambo pottery is surprising. As most of the early ironworking sites found in East and Central Africa are located either along perennial rivers or lake shores (Clark 1974; Schmidt 1978; Mapunda and Burg 1991; Haaland 1993), the southeastern Lake Tanganyika shore would be expected to have been an attractive eco-zone for the early ironworking communities.

The paucity of early ironworking materials along the shore is perhaps due to both natural and cultural factors of site formation processes. The principal natural factors are the

landscape and the periodic fluctuation of the lake. We learned in chapter 2 that the lake is bounded by both precipitous uninhabitable escarpments and narrow habitable plains, most of which are less than a kilometer wide (except Kirando). Because the lake level fluctuated (D.D.Y. 1957; Livingstone 1965; Haberyan and Hecky 1987), the plains were inhabited only at low levels. During the high level periods people migrated to the highlands, the escarpment terraces or the plateau proper. The limited habitable land itself is a threat to archaeological remains because it forced people to repeatedly return to the same places whenever the lake receded. Thus, the old cultural materials were subjected to continuous disturbance through cultivation, constructions, and ditch and channel digging for field-fencing. Furthermore, during high lake level periods cultural remains which otherwise would have remained *in situ* were eroded and washed to other locales.

The fact that the plateau and the escarpments lacked wide, arable river plains and fishable rivers may also explain the paucity of Early Iron Age materials there. However, given that the investigations on the high altitude region (the Fipa escarpment and the plateau) was limited in aerial coverage, this explanation should be regarded as hypothetical. The terraces on the escarpment and perhaps the plateau seem to have been preferred by Stone Age communities. One "Later Stone Age" site was found at King'ombe on the escarpment where a 4 km^2 area was surveyed. This leads to the speculation that additional

Stone Age sites might be found on the plateau and the escarpments with more extensive survey.

The Iron Age Culture History in Nkansi District

The Early Iron Age

We noted in chapter 2 that the linguistic evidence suggests that by around 0 A.D. the southeastern shore of Lake Tanganyika was already occupied by proto-corridor Bantu-speakers, the makers of iron and Urewe related pottery (Ehret 1991). We also noted that the 0 A.D. date provided by the linguists is not supported by archaeological findings from Kalambo Falls (Clark 1974). I would like to revisit this discussion in the light of findings from the current research project at Kirando.

Clark (1974) observed that the cultural remains of the Early Iron Age population in the Kalambo basin were distinct from those of the present-day inhabitants, the Lungu, both in pottery types and other cultural materials. The Lungu culture was represented only in the uppermost level of the excavations. The lower levels, dating from about 400 A.D. to about 1000 A.D., contained the Kalambo tradition--a type of pottery related to both the Urewe Ware (dimple-based) from the interlacustrine region and the Mwabulambo and Gokomere traditions from Malawi and Zambia to the south.

This type of pottery was also found around Kirando, particularly at sites Hvlk-6, -11, -26, -56, -57, and -58. Stratigraphic examination at site Hvlk-58 (a site with the least disturbance and relatively high amount of cultural materials) revealed that the Kalambo pottery was common at the lower levels (30-45 cm below datum) as shown in table 6.21.

The Early Iron Age components (400-1000 A.D.) at the Kalambo Falls sites have also yielded some metallurgical materials including slag, tuyere fragments, hammer stones, an anvil, and iron tools and ornaments such as spear- and arrow-heads, tangs, arm or leg rings, and finger or toe rings. Furnaces have not been identified. It is clear from the slag and tuyere descriptions, however, that the ironworking technology practiced at Kalambo Falls during the Early Iron Age was different from the three technologies (katukutu, malungu and Barongo-type) found north of Kalambo Falls during this investigation.

Does this mean that the makers of the Kalambo type pottery in the first millennium A.D. at Kirando did not make iron? It is very likely they did make iron. The absence or scarcity of metallurgical remains there is possibly due to continuous disturbance caused by repeated settlement as discussed above in relation to pottery, as well as the difficulties involved in identifying ironworking technologies based on pieces of slag and tuyeres found in secondary locations. In other words, it is much easier to identify a potsherd as to its general type or tradition (e.g., Kalambo) than

to associate a small piece of tuyere or slag to a particular technology. This is because potsherds, especially rims bear more diagnostic attributes such as decoration, rim form, temper, paste, burnishing, slip and many others than tuyeres or slag. For this reason I am tempted to believe that the slag and tuyere pieces we found at site Hvlk-58 (Tables 6.18 and 6.20) where Kalambo pottery was also found relate to technology practiced by the makers of the Kalambo pottery. Unfortunately, they are too few and too fragmentary to warrant a definitive conclusion.

Other Early Iron Age activities revealed at the Kalambo sites include settlement evidence indicated by daub, grindstones fragments, burnishing stones, and pestle stones; trade is suggested by copper objects (a bracelet and a small, hollow, conical object made from thin copper sheet); and cattle (Bos taurus) domestication is indicated by bone (Clark 1974). Our investigation at Kirando also revealed some daub, cattle bones, and a copper bead (see chapters 5 and 6).

The archaeological evidence summarized above indicate that generally, the southeastern shore of Lake Tanganyika shared a similar culture during the Early Iron Age. Let us now juxtapose this with the linguistic evidence.

We noted in chapter 2 that the linguistic evidence suggests that the early ironworking communities (both the Kusini and the proto-Corridor Bantu) arrived in the corridor region "by the first centuries A.D. if not before" (Ehret 1991:50). Ehret also suggests that the southward route of the proto-

Corridor Bantu-speakers was "perhaps initially along the west of Lake Tanganyika" (Ehret 1991:50).

So, where does this lead us? In the light of the current archaeological records from both Kalambo and Kirando it seems that Ehret's dates have been pushed too far back. The earliest chronometric date from the Kalambo Falls sites is 400 A.D. (Clark 1974). However, Ehret may be correct in postulating a rhythmic movements of population in the area. Archaeological and ethnographic evidence from Kalambo Falls, Kirando, and Ivuna suggests that the southwestern Tanzania region witnessed continuous population influxes throughout the last 1600 years.

Based on the current evidence, we can make the following tentative conclusion. The southeastern Lake Tanganyika shore was colonized from around 400 A.D. by people (probably Bantu-speakers) who made the Kalambo pottery. These people also produced iron by a technology about which we know virtually nothing up to now. They were also keeping cattle, as well as making or trading in copper materials as early as 1000 A.D. They preferred to settle along the shore or perennial rivers.

The Kalambo pottery (and perhaps metallurgical skills) continued to change through time. By 1000 A.D. a new pottery type became prevalent. The stratigraphic evidence shows that the transition was slow and more likely an organic one. The subsequent pottery is referred to here as TIW (Triangular Incised Ware) because of its affinity to the TIW commonly found along the Indian Ocean littoral (see chapter 5 for attributes)

dating between the seventh and the twelfth centuries A.D. (Chami 1994). Kirando, is, therefore the farthest site from the coast (about 900 km) so far recorded with TIW pottery. Some other interior (over 200 km from the coast) sites with authentic and probable TIW include Dakawa, east-central Tanzania (Haaland 1993); Usambara, northeastern Tanzania (Soper 1967b); Kilosa, northeastern Tanzania; Kandaga, north of Dodoma, central Tanzania (Chami 1994); and Ruhuhu basin, southern Tanzania (Mapunda 1991b).

Since the TIW pottery is traditionally said to be a coastal (Indian Ocean) material culture (Horton 1985; Phillipson 1985; Fawcett and LaViolette 1990), its location in the interior often raises questions, particularly in regards to cultural links with the coast. Two hypotheses can be used to account for this "unusual" occurrence for the present. First, as Chami (1994) would argue, the TIW developed organically from the Early Iron Age pottery (e.g., Kwale) along the coast (east-central Tanzania) around the middle of the first millennium A.D. and the knowledge, rather than the pots, spread to the other parts of eastern Africa. This pattern of spread complies with the slow transition observed at Kirando (site HvIk-58). The second hypothesis is similar to the first one in mode of spread, but differs in place of origin: instead of originating along the coast, the TIW originated in the interior (probably east of the great lakes region) and spread to the east. To test these hypotheses we need further research, especially in the interior.

The cultural stratigraphy both at Kirando and along the Indian Ocean littoral show that the transition from the Early Iron Age pottery to the TIW was gradual rather than abrupt. This seems to oppose the view that the spatial distribution of the TIW pottery in eastern Africa was caused by population migration (Soper 1971c, 1982; Horton 1984). It is very likely that trade, both short-distance and long-distance, as well as inter-ethnic relations such as marriage were the principal media of transfer of TIW pottery in eastern Africa. This does not necessarily mean that pots *per se* were physically transported from place to place (e.g., as long-distance trade items). What I mean is that trade facilitated the spread of the knowledge of pot making. In other words, trade brought about inter-ethnic interaction resulting in the spatial transfer of the knowledge of pot making. Physical transportation of the TIW pots in long distances was perhaps hindered by the large size of some of the pots and the fragility of clay pots in general. As Chami argues, in order to accept this hypothesis we need to show that "it was cheaper and easier to import pottery than to produce it locally" (Chami 1994:99), a research problem which we have not yet addressed.

The cultural stratigraphy at Kirando shows a sparse distribution of materials (Ivuna pottery) between the twelfth and the fifteenth centuries, suggesting a low population density. Since the hydrologic history of the lake indicates that the eleventh century was a period of high water level (Livingstone 1965; Street and Grove 1976; Haberyan and Hecky 1987; Scholz

and Rosendahl 1988; Davison 1991; Ntakimazi 1992), we can hypothesize that there was a noticeable population migration to the interior at this time period following the lake floods. As the lake receded in subsequent centuries, emigrants, including the present day inhabitants, the Fipa to the north and the Lungu to the south slowly re-occupied the shore (only to abandon it again, however briefly, in the 19th century for the same reason, lake floods (D.D.Y. 1957)).

However, it is interesting to note that further east, along the Lake Rukwa valley (Ivuna salt working site), Fagan and Yellen (1968) report of an abrupt occurrence of a pottery component (Alpha), in the early thirteenth century. They note that the "Component Alpha does not ... belong to the channel-decorated pottery tradition, which is associated with the earliest Iron Age settlement of the northern parts of Zambia", and that "the carbon dates from Ivuna indicate that the salt-working villages are slightly later than the closing stages of the Kalambo sequence" (1968:32). Since this pottery type (component alpha) occurs at Kirando above the TIW pottery, and if it is true (as hypothesized above) that some lake shore dwellers migrated to the interior following the lake encroachment after the eleventh century A.D., it is very likely that component alpha was introduced to the interior (including Lake Rukwa basin) by migrants from the southeastern shore of Lake Tanganyika.

The pottery found above component alpha at Ivuna (called component beta), has some affinity with the pottery of the

present day inhabitants of the area--the Nyamwanga, Wanda, and Nyiha--and Fagan and Yellen suspect that they are direct descendants.

Later Iron Age

The chronometric dates obtained from this research (Table 6.22) indicate that the period between A.D. 1550-1750 witnessed significant socio-cultural changes in Nkansi District. The changes are associated with the introduction of the katukutu ironworking technology and the related pottery (Katukutu tradition) along the shore of Lake Tanganyika. The abrupt appearance of full fledged iron technology and new pottery type indicate that a large scale population influx took place during this time (16th-18th centuries) and that these newcomers brought with them the katukutu iron and pottery skills. Who were these people and where did they come from?

Oral traditions indicate that these people were the present inhabitants of this area: the Lungu south of Kala (including Kalambo Falls) and the Fipa north of Kala (including Kirando). According to Clark (1974), the genealogy of the Tafuna chiefdom on the lake shore suggests that the Lungu established themselves in Kalambo in the seventeenth century. Lungu oral traditions hold that Kalambo was initially inhabited by the Fipa. "If so," Clark argues, "it would seem that the Fipa must have entered the valley some time after the eleventh century, perhaps in the sixteenth century, since up to the earlier date, if not later, it was occupied by the makers of the Kalambo

Falls Industry who, though most probably of Bantu Negroid stock, made a very different kind of pottery" (Clark 1974:1), namely Kalambo tradition.

The genealogy of the Milansi kingdom of the Fipa indicates that the Fipa arrived in their present-day home (north of Kala and the Fipa plateau) around the mid-seventeenth century (Willis 1968, 1976, 1981). In his words, Willis says, "a reasonably plausible terminus ante quem would place this event [i.e., arrival of the Fipa] somewhere in the middle of the 17th century, say 1650" (Willis 1976:4). He further cautions that "I would also insist on the extremely tentative and provisional character of these dates. Hopefully, archaeological research at Milansi and the sites on other royal villages in Ufipa may eventually illuminate these obscure matters" (Willis 1976:20). Although this research did not investigate the royal villages, evidence from the excavated sites along the shore support Willis' genealogical reconstruction.

While the Lungu traditions claim that their present land was occupied by the Fipa prior to the seventeenth century (Clark 1974), the Fipa have two different accounts as to who was in Ufipa before their arrival. The first claims that the land was empty and the second, which is more popular, claims that the land was inhabited by people of a small stature (Mbonelakuti) "who often took to hiding when they came into contact with the Fipa"[1]. This investigation has not been able to establish for certainty the ethnic identity of those who occupied Fipaland

[1] According to Vincent Kayanda (79/80), interviewed at Kala on November 28, 1992.

prior to the present-day inhabitants. Although circumstantial evidence seems to suggest that the predecessors were ancient Fipa, the Mbonelakuti hypothesis cannot be ruled out unless direct evidence, such as skeletal remains, is found (see discussion below).

History and Variation of Ironworking Technology in Nkansi District

This research project has revealed three ironworking technologies: the katukutu, the malungu and the Barongo-type that were practiced in Nkansi District during the later Iron Age. These technologies differ not only in metallurgical components, but also in spatial and temporal distributions. The katukutu technology is the oldest of the three; it dates between 1550 and 1800 A.D, whereas the malungu and the Barongo-type technologies date later than the mid-nineteenth century (Fig. 6.22). However, given the limited aerial coverage of this research on the plateau, and the limited number (3) of sites with evidence for the Barongo-type technology, the dating of the malungu and Barongo-type technologies are only tentative. A more extensive archaeological investigation on the plateau is needed in order to make a sound conclusion.

The technological variations have been discussed in detail in chapters 5, 6, and. 7. In this section I discuss three issues that were not fully covered in the previous chapters. First I

attempt to reveal the ethnic identity of the iron smelters; second, I account for the inter- and intra-technological variations observed in the ironworking technology in this area; and finally, I present the role of ironworking sites in the day-to-day lives of the present-day inhabitants.

Ethnic Identity of the Iron Smelters

Who made the katukutu furnaces? We noted in chapter 5 that the people living along the shore today attribute the katukutu technology to the Mbonelakuti (or Batwa). The Mbonelakuti legend is not unique to Nkansi District but is rather common among Bantu-speakers in East and Central Africa. This explains why they attracted research in the 1950s and 1960s (Clark 1950; Procter 1960; Rangeley 1963). Research on the Mbonelakuti declined since then, probably because many investigators believed (probably erroneously) that the Mbonelakuti were mythical rather than real since none of their living representatives was found (Juwayeyi personal comm.). It is worth reviewing their literary and oral coverage, however, because they relate to an important discussion here.

These people are referred to differently in Bantu folklore. Their names include Mwandionerakuti (or variation of that name such as Mwandionerapati, Amambonela, or Mbonelakudene), Akafula, Batwa, Mbolela pano, Utunuta mafumo, Utunkula mafesa etc. (Clark 1950; Rangeley 1963). Although different names are used, all Bantu traditions agree that these "were little people, hardly reaching to the waist of a man [Bantu person?], and they

were very touchy about their small stature" (Rangeley 1963:37). The reason why they were called Mwanionerakuti for example, has to do with their stature. As Rangeley reports,

> If a person met one of them, the little man would come close and ask "mwandionerapati?" or "mwandionerakuti?"--where did you see me?" If the answer was given "I saw you a long, long way off" the little man was satisfied, because it showed that he was a big person capable of being seen a long way off, but if the reply was given "I saw you close by", woe betide the man, for the little aMwandionerakuti would shoot him in the stomach with their poisoned arrows (Rangeley 1963:37).

In regards to ironworking there are two opposing views. Some scholars (e.g., van der Merwe 1980; Juwayeyi, pers. comm.) hold that the Mbonelakuti were Stone Age people and had no knowledge of iron working. Van der Merwe, for example writes:

> Before the advent of Iron Age, eastern and southern Africa was populated by sparsely distributed bands of stone Age hunter-gatherers. Modern surviving remnants of these peoples can be found among the Bushmen [San?][2] of Botswana and the Kalahari desert. ... During the second half of the 1st millennium a.d. and during the Later Iron Age which follows, Iron Age populations increased progressively in the southern subcontinent. The area involved is vast and there was little competition against these metal-equipped farmers and pastoralists. The Stone Age inhabitants were absorbed through client relationships and marriage, or compressed toward the southwestern tip of Africa (van der Merwe 1980: 480 and 482).

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[2] Some scholars (e.g., Rangeley 1963) argue that the San and Mbonelakuti are different peoples. "The Akafula or BaTwa were not Bushmen. They were black pygmies" (Rangeley 1963:37).

Others, including Clark (1950) and Rangeley (1963), hold that some Mbonelakuti knew how to make iron. Insisting on their knowledge of iron working, Rangeley writes:

> What clearly and sharply distinguished them [Mbonelakuti] from the Bushmen [San] was their knowledge and use of iron, and the entire lack of stone implements. Their arrows were made either of wood with no more than a fire-hardened point or were tipped with iron. They had a characteristic long heavily barbed iron head without the usual flattening and broadening, which were either arrow heads or spear heads... (Rangeley 1963:38).

Personally, I believe that some of the Mbonelakuti communities had the knowledge of ironworking. In addition to the claims by some Bantu-speakers, such as the Fipa, Lungu, Bemba, Cewa, and others, that the Mbonelakuti made iron, linguistic and archaeological studies in southern and southwestern Africa seems to support this line of thought. New studies (Ehret 1982b; Denbow 1990; Kiyaga-Mulindwa 1993) challenge the traditional claim that iron technology in southern Africa was recent (belief tied to the Bantu package, see chapter 3). It is now evident that iron technology, pastoralism and political organization date to the fourth century A.D. or probably earlier in that area (Kiyaga-Mulindwa 1993). This offers two possible alternatives: first, Bantu-speaking people migrated into southern Africa much earlier than initially thought. This alternative, as Kiyaga-Mulindwa notes,

> does not tally with the prevalent explanation of the spread of Bantu-speaking people in the region. This new evidence replaces the two-streams theory in favour of

> multiple streams over a broad front (Kiyaga-Mulindwa 1993:389).

The second alternative, is that the pre-Bantu communities (including Mbonelakuti) had the knowledge of ironworking, pastoralism and political organization before the arrival of Bantu-speakers (Ehret 1982b; Denbow 1990).

Does this, therefore, suggest that the katukutu technology found in southeastern shore of Lake Tanganyika belonged to the Mbonelakuti? It is difficult to say at this time. The current research did not yield enough evidence to warrant a definitive answer to this question. Although oral traditions attribute the katukutu technology to the Mbonelakuti, the archaeological evidence seems to contradict that claim. For example, the chronometric dates of the katukutu technology (16th-18th century A.D.) complies with the genealogical dates which point to the arrival of the Fipa and Lungu from Uluba. Additionally, a comparative analysis of some important technological and ritualistic attributes (Table 8.1) between the katukutu and the malungu technologies indicates that the two technologies are historically related: the malungu technology very likely evolved from katukutu technology. This also suggests that the smelters of the two technologies may have been ethnically related. Since we know that the malungu technology was practiced by Fipa people, it is highly probable that the katukutu technology was also practiced by them. For more discussion on this comparison, see "Variations" below.

Who made the Barongo furnaces? The oral traditions are not specific on this subject. There are accounts, however, of individual smelters who immigrated from the north around the beginning of this century. For example, one informant (Elias Mwami), who lives in Kirando said that his grandfather, Mzee Makangila, was an iron smelter who had migrated from Ugogo (Dodoma Region). When he arrived in Ufipa, Makangila settled at Ntunchi, on the plateau where he conducted one smelting experiment with a low-shaft, Gogo furnace. When we asked why Makangila did not continue with his work, Mwami answered readily, "his 'dawa' [medicine] were not as powerful as those of the Fipa".

Although Makangila did not come from Geita District, (the center of the Barongo technology), his case shows the possibility of individual Barongo smelters immigrating into Kirando from Mwanza Region and experimenting with their home technology there. This would not be unusual, because as I noted in chapter 2, immigrants (Sukuma herders and farmers) from Mwanza and Shinyanga Regions to the north continue to immigrate into Nkansi District until today.

Explanations of the Inter- and Intra-Technological Variations

In the last three chapters, we observed that both inter- and intra-technological variation existed in the ironworking technology in Nkansi District and southwestern Tanzania in general. Emphasis in those chapters was put on the inter-technological variations. This helped to illuminate differences

between the technologies and explain why they are considered to be different technologies as opposed to technological variants or styles. A summary of selected variables used to compare and contrast the three technologies found in Nkansi District (katukutu, malungu and Barongo-type) is presented in table 8.1. The table shows that the katukutu and malungu technologies match in nine variables (# 3, 5, 6, 8, 11, 16, 19, 20 and 21) or 41%; the katukutu and Barongo-type technologies match in five variables (# 13, 15, 16, 20 and 21) or 23%; and malungu and Barongo-type technologies match in seven variables (# 1, 4, 12, 16, 18, 20 and 22) or 32%.

In this sub-section, I focus again upon similarities between technologies for the purpose of determining both historical and cultural relationships between them. I also examine variations within the technologies in order to understand their meaning. In other words, I intent to establish whether they mean experimentation, technological style, belief styles, or something else.

Table 8.1 Comparative Table of Selected Variables from the Three Technologies Found in Nkansi District

VARIABLE	KATUKUTU	MALUNGU	"BARONGO"
1. Furnace morphology	globular	truncated cone	truncated cone
2. Furnace height	70-120	250-350	150-200
3. Construction materials	termite clay	termite clay	slabs from termite mound
4. Wall layering	present	absent	absent
5. Association with termitary	present	present	absent
6. Furnace reuse	present	present	absent
7. No. of tuyere ports	8	10	5
8. Palinyina	present	present	absent
9. Tuyere length	40-54 cm	24-30 cm	60-70 cm
10. Tuyere diameter (external/internal)	4/2.5	7/2.5	6/3
11. No. of tuyeres per port	multiple (3)	multiple (3-4)	single
12. Tuyere reuse	present	absent	absent
13. Fuel trees	highly selective	less selective	highly selective
14. Slag amount	low	high	medium
15. Slag tapping	absent	present	absent
16. Slag reuse	present	present	present
17. Vizimba at the furnace center	pot and herbs	wood strips	hole
18. Ore type	magnetite, hematite	limonite, laterite	laterite?
19. Draft	natural	natural	forced
20. Distance from residence	away	away	away
21. Spatial distribution	lake shore and escarpment	plateau and escarpment	lake shore
22. Chronology	400-300 B.P.	100-20 B.P.	100-20 B.P.

Africa "occupies a clear first place in the history of iron metallurgy" in terms of variety of its furnace designs (van der Merwe 1980:489). This may be due in part, "to the late survival of many traditional smelting methods and their consequent recording in ethnographic accounts but, the variety of local inventions plays a principal role as well" (van der Merwe 1980:

489). The question troubling students of indigenous African metallurgy (Cline 1937; Kense 1985; Childs 1991c) is then, why Africa was so prolific in local inventions?

Two major factors seem to have contributed most: the heterogeneity of its natural resources and the variability in cultural beliefs. Unlike temperate regions (e.g., Eurasia) which tend to be homogeneous, especially in biological resources, a large area of Africa lies within the tropics, a region notoriously heterogeneous in flora, fauna, rainfall, and soil distribution (Minns 1984).

This can be illustrated by a case of trees used as charcoal fuel. It has been noted in this research (chapter 6), as well as in other studies (Schmidt and Avery 1978; Killick 1990; Roberts 1993), that iron smelters often had a preference for hard trees with little ash content. These included Mbanga (Pericopsis angolensis), Mngongoma (Afzelia quanzensis), Msangu (Acacia albida), Muchwezi, Mfundwa, and Mgwina. It is also true that hard trees take a longer time to regenerate (Kikula 1979). This means that if a certain tree species in one area was selected for iron smelting fuel there was a good chance that demand grew faster than the regeneration rate of that specific tree and this resulted in depletion. In order for the smelters to continue working, they were faced with two options: 1) migrate to another place where that tree was available, or 2) experiment with other species. The first option was ideal where land was abundant or territoriality was not an issue. But most ironworking societies in Africa were economically based on

agriculture which was sensitive to territoriality and involved low mobility. Therefore, experimentation with other species seems to have been more preferable option by iron smelters.

This is clearly demonstrated in the interlacustrine region of East Africa where a sedentary way of life and farming have a long history (Schoenbrun 1993). Schmidt and Avery (1978) suggest that "the evolution of the fuel-efficient preheated furnace [there] may be an adaptation by the local smelters to that [forest] depleted resource" (Schmidt and Avery 1978:1089) caused by charcoal exploitation and land clearance for agricultural purposes. In addition to preheating, Schmidt and Avery also note that through time the smelters shifted from depending on trees alone (e.g., Muchwezi) to using swamp reeds (Ishenga) for fuel (source of carbon) (Avery and Schmidt 1979). There is little doubt that such changes came through experimentation.

We noted in this research that the katukutu smelters were more selective in the fuel wood they used as compared to the malungu smelters. The charcoal found in the katukutu furnaces came from hard wood including Mbanga (Pericopsis angolensis), Mngongoma (Afzelia quanzensis), Msangu (Acacia albida), Mfundwa, and Mgwina, whereas those from the malungu furnaces consisted of a mixture of hard and light wood such as Mbula (Parinari curatellifolia), Msuku (Uapaca kirkiana), Msumbu (Brachystegia manga), Mninga (Pterocarpus angolensis), Mtumbe, Kulungu, Mwenge, Kalunguti, Mtembo, and Chikali. When we asked the former smelters why they were less selective in

charcoal wood, they argued that they could not afford to be selective because hard woods are generally more sparsely distributed and it was uneconomical to use them given the size of the furnaces[3].

Ore quality is another important ecological factor. It has been argued by some researchers (van der Merwe and Avery 1982; Sutton 1985; Davison-Hirschmann and Mosley 1988) that the emergence of and subsequent preference for the tall, natural-draft furnaces in Ufipa and the region south of it, was a function of ore quality. They claim that iron-rich ores such as magnetite (Fe_3O_4) and hematite (Fe_2O_3) were optimal for short furnaces.

This research supports this line of argument. The small, katukutu furnaces employed hematite and magnetite ores, whereas the large malungu furnaces used limonite and lateritic ores. However, this should not be taken as a general law. Childs (1989), for example, who has conducted petrographic studies on ore samples from Early Iron Age bowl, forced-draft furnaces, and from experimental smelts conducted in the 1970s in Buhaya (using short, forced-draft furnaces) notes that the kind of ore used for the entire Iron Age period there was limonite ($FeO.OH.nH_2O$) and goethite ($FeO.OH$).

The relationship between furnace size and ore quality, as suggested by this research, should be explained in terms of labor cost vis-a-vis final return (iron). Let us suppose that 10

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3 An experiment conducted in 1982 in the Kasungu district showed that a single smelt in a malungu furnace consumed 1.45 tonnes of charcoal in 114 hours to smelt 75 kg of laterite ore (Killick 1991).

kg of iron-rich ore (e.g., magnetite) smelted in a katukutu furnace yielded 2 kg of bloom. What would happen if the smelter had access only to iron-poor ore that yielded say 1 kg of bloom from 10 kg of ore when smelted in a katukutu? In order to meet his normal demand (2 kg) the smelter would need to smelt 20 kg of the iron-poor ore. To do that he would be faced with two options: either conduct two smelts in a furnace of 10-kg capacity (katukutu), or conduct one smelt in a furnace of 20-kg capacity (malungu). There is little doubt that the later option would be optimal considering the labor involved in collecting ore, preparing charcoal and constructing furnaces.

Some scholars argue that the emergence of tall furnaces was caused by the need to create a natural draft required to provide a "sufficiently powerful [draft] to increase the combustion temperatures to the level at which carburization of the bloom occurred. Such a draft could be achieved ... if the shaft itself was tall" (Kense 1985). This explanation may be too simplistic. In this research we found that katukutu furnaces, which do not measure more than 120 cm tall, employed a natural-draft mode of combustion. That is to say, natural-draft in iron smelting had no causal relationship with tall furnaces. In Ufipa, at least, natural-draft mode of combustion seems to have been invented probably three centuries before the emergence of tall furnaces and it was used in furnaces measuring only 70-120 cm-tall.

This research also indicates that the change of furnace size, especially width, may have been influenced by symbolic or

ritualistic stimuli. Both building layers of walls outside old ones instead of building new furnaces altogether as observed in the katukutu technology and building new furnaces around the plans of old ones (Fig. 6.10) instead of locating them in new spots point to the need to conserve the highly valuable ritual medicine (vizimba). It should be emphasized that the knowledge of vizimba was the key to controlling the knowledge of iron smelting. As one former smelter argued, master smelters (silungu) of the malungu technology used young, sexually innocent boys and girls to help them in the process of sanctifying the furnace before smelting not only to use the purity of the young assistants but also to protect the 'patent right' of their vizimba.

The process of obtaining some of the vizimba ingredients was laborious, dangerous, and sometimes involved human sacrifice. Although vizimba consisted of various materials ranging from fauna and flora to rocks, all of which were known only by the master smelter (silungu), there was one important item which appears in local folklore all over Central Africa. This was a snake called nguvwila (or variants of that name such as ingufwila and inyuvila) (Brock and Brock 1963; Roberts 1993) literally meaning "that which breathes". It is believed that this snake was very venomous and people died even from its breath. The snake was long, big and red in color. The process of trapping this snake involved human sacrifice.

According to one tradition the process of trapping nguvwila was communal, involving the whole clan or chiefdom.

The process involved selecting a boy for sacrifice, searching for a place where the snake lived, building a small wooden fence, putting a boy (or rooster) inside it as bait. One tradition claims that the snake then came out following the scent of the boy (or the crowing of the rooster), got into the fence, killed and swallowed the boy/rooster, but could not get out because the spaces between the fence posts were not wide enough. After two to three days, the trappers came and killed the snake easily because it could not move. The snake was then divided among the master smelters as well as clan heads or chiefs (for the protection of the community). Each master smelters would mix a small piece of nguvwila with other ingredients and bury it at the base of each furnace he built.

Whether the technique of catching this snake is real or mythical is hard to tell.. But there is no doubt that vizimba were highly valued. Once installed in a furnace, the smelters continued to use that place as long as they could by adding new walls outside the old ones or building new furnaces once the old one collapsed (see chapter 6). Consequently, the outer (secondary) furnaces were becoming progressively larger compared to the inner (primary) ones. This process resulted in gradual change of furnace size through time within the katukutu and malungu technologies and probably between these two technologies.

The Significance of Ironworking Sites to the Living People

Unlike most technologies practiced during the Iron Age, such as basketry, textile, mat weaving, etc., ironworking was given a special social, political, and economic status by the African populations (de Maret 1985). Among the Bahaya, for example, ironworking was associated with the ruling class. The technology was under the direct control of the chief who was also considered, symbolically, the principal ironworker (smelter and smith). Schmidt observes that when a chief was installed one of the most important procedures included performing a symbolic ironworking by beating the anvil (Schmidt 1978a). Additionally, important regalia in the society included iron tools.

The Fipa were not different. Interesting ethnographic observations have been made by previous researchers, especially Wyckaert (1914), Willis (1981) and Barndon (1992), and it is not worth repeating them here. Instead, I will supplement those studies by focusing on the role of iron-smelting sites to the contemporary society.

Most people, especially Fipa and Lungu, believe that the medicine (vizimba) used by iron smelters centuries or decades ago have eternal power. This power is not only on the vizimba themselves, but also on the site and all materials related to iron smelting including slag, tuyeres, and furnaces. It is not unusual to find ordinary Fipa, Lungu, and local healers who keep pieces of these materials in their homes. This is not for esthetic reasons, but rather as medicine, "kinga" (protection

against evil intentions), and charm (good fortune). In Kala, for example, we found a house built on top of an ironworking site (site Iall-2). When we asked the owner (Petro Salamba) why he decided to build his house on top of an ironworking site he said that he believed that he was assured of the blessings and protection from ancestral spirits.

The most common problems treated with ironworking materials include infertility and stomachache. In this case slag and furnaces are the most common materials used. Slag is often ground up and about a tenth of a gram of the powder is used as "kizimba" (principal ingredient) in a mixture of herbs. It is believed that the herbs by themselves cannot work (cure infertility). The furnace is used in two ways: either the healing process takes place inside it, in which case both the patient (allegedly naked) and the healer enter and exit the furnace through the palinyina, or the healing process is performed outside and sacrificial items (e.g., a head of a roster and some herbs) is placed inside the furnace by either the patient or the healer. This was noted at site HxIo-5, Kalundi.

I asked local healers why they used remains of ironworking for treating infertility. The following is an extract from an interview with Mama Ana (February 20, 1993):

> Question: Why do you use remains of ironworking for treating infertility?
> Answer: Don't you know that iron smelting and birth are the same?
> Question: How?
> Answer: In iron smelting they [smelters] put nyiimbo (iron ore) into the furnace and a baby is born, iron.

In human birth you know what is put into a woman (laughter) and a baby is born.

Question: O.K., O.K., but why do you use lombwe (slag) which is a by-product instead of iron, the real 'baby'?

Answer: Iron? Where is pure iron? Slag is pure, it has not been contaminated. It also underwent all processes of transformation as iron did and passed through palinyina [birth canal]. The iron you see today belongs to the white people ("chuma cha kizungu"). It can't work. If you find ancient iron in your research bring it to me, I will pay you.

The central point here is that ironworking symbolizes human reproduction (see also the discussion in chapter 5 regarding the placement of palinyina on the western side of the furnace).

The old materials are also exploited by iron smiths who use the tuyeres, not because they cannot make their own, but because the old tuyeres are believed to possess powers for healing, protection, and assurance of success. In the past, large blocks of slag were also used as hammers to sharpen grind stones.

Future Research

Although this research accomplished its initial goals, it has also stimulated more questions than provided answers. Several areas that need more work have been noted throughout this work. I would like, in this section, to highlight the most relevant areas related to the reconstruction of the culture

history of southwestern Tanzania and East and Central Africa in general.

First, this research has indicated that the period between the 16th-18th centuries witnessed major population movements in the corridor. The source and causes of these movements are only known through oral traditions. We need for example to trace the alleged routes back to Lubaland, Tabwaland, and Bembaland to verify these oral accounts.

Second, although the current evidence favor the Fipa as the makers of the katukutu furnaces, the possibility of the Mbonelakuti remains a substantive hypothesis that needs to be tested. We need to find skeletal remains associated with the katukutu technology and determine their ethnic identity (e.g., through DNA studies). Meanwhile, collecting more materials (other than technological) can also help to tell more about the people with whom we are dealing.

Third, we need to search for trade links between the eastern and the western shores of Lake Tanganyika, as well as between the lake and the Indian Ocean littoral, in order to be able to account for the occurrence of the TIW pottery and the copper materials along the southeastern shore of the lake. Fourth, surveying more extensively on the plateau for the purpose of determining the earliest occurrence of malungu technology in Ufipa will help to learn more about the history and the development of this technology. Fifth, excavations need to be conducted at the royal villages of the Fipa and Lungu

chiefdoms aimed at directly verifying the oral traditions on the arrival of the two peoples in this area.

Sixth, although local people claim to have seen the katukutu furnaces as far south as northern Zambia, we are not sure of their chronology. We need to conduct archaeological research that will yield materials to confirm that the technology is the same. We also need to obtain datable materials that will provide a chronological sequence for the two regions.

Seventh, there is a need to determine a technological explanation for the paucity of slag in the katukutu technology. I noted in chapter 7 that, although some slag was reused in various ways (including re-smelting in the Barongo-type technology, healing, and miscellaneous domestic purposes) and some was lost through corrosion, the fact was that the technology seems to have had yielded little amount of slag. We do not know yet how or why this occurred. The fact that the smelters consistently continued to built new wall layers around the old ones (instead of building new furnaces altogether) may indicate that smelters deliberately used low refractory clay for furnace construction and tuyere making for the purpose of fluxing the high-iron content magnetite ore they used. To find this out for certain we need to conduct smelting experiments and chemical analysis of the soil used for furnace construction and tuyere making. The experiments will also help to demonstrate how the smelters managed to use a natural-draft technique on such short furnaces.

APPENDIX A

AN ANNOTATED LIST OF INFORMANTS WHO WERE FORMALLY INTERVIERWED

Kirando

Dominiko Kazumba Kiputwi (75)*: Interviewed alone (as opposed to a panel) on October 26, 1992. He is a Fipa, born near Chala, on the Fipa plateau. He came to Mpata (Kirando), his current residence, in 1967 following good farmland. He is a farmer.

Fabian Makanta Kimbelekete (74): Interviewed in panels on October 3, 1992, and February 9, 1993, and alone on February 13, 1993. He is a Fipa, born at Namanyere, Fipa plateau. He finished Standard Three in the early 1930s and worked as a veterinary for the colonial government (British) in the early 1930s, served in the British army during World War II, and worked as a Prison officer after the war. He lost this job in the late 1950s for political reasons: he was caught in possession of TANU[1] membership card (which was illegal for civil servants). He then resorted to elephant hunting and practicing traditional medicine. Both activities helped him to become acquainted with the wilderness in Ufipa and

* The number in the brackets is the age of the informant on the day of interview.

[1] TANU = Tanganyika African National Union, the political party, established in 1954, to fight for decolonization of Tanganyika (the current Tanzania mainland) from the British.

Ulungu (northern Zambia). In this research he was recruited as a field helper. He was very useful in identifying animal species from bones collected during site survey and excavations.

Bonventura Dominic Mwanamarwa (72): Interviewed in a panel on February 9, 1993. He is a Fipa, born at Kirando, on the lake shore. He is a renowned honey collector and well acquainted with the wilderness around Kirando and as far north as Kabwe. He was a field helper, and well informed about the history of Kirando.

Klement Silungu (70): Interviewed alone on October 16, 1992. He is a Fipa, born at Pito, near Sumbawanga. He came to Masolo (Kirando), his current residence, in 1975. He belongs to the iron smelting clan (<u>isilungu</u>). Both his father and grand-father were iron smelters (<u>isilungu</u>). Clement laments that the technology on the plateau was repressed (by the colonial government) before he learned how to smelt. However, he still remembers what he observed as a young boy from his father.

Rev. Fr. Boniface Kitara (70): Interviewed alone on November 15, 1992 and revisited on October 17, 1993. He is a Tabwa, born in Burundi, but ordained in Tanzania. He has worked in various mission station along the shore of Lake Tanganyika, including Karema, Utinta, Kala, and Kirando, his present station. He is well informed about the missionary history along the eastern shore of Lake Tanganyika.

Julius Thomas Malibanga (69): Interviewed in a panel on October 3, 1992 and revisited alone on October 17, 1993. He is a Fipa, born and grew up at Kirando. His occupations include farming, fishing, and honey collecting. He was very instrumental in identifying tree species of the excavated charcoal.

Nicolas Songaleli (68): Interviewed in a panel on October 3, 1992. He is a Fipa, born at Mkole, Fipa plateau. He came to Kirando with his parents in 1933. He is a farmer, but he has been involved with religious activities since 1961, holding several leadership position in Kirando Parish. Currently he is the chairman of the parish council at the Kirando Roman Catholic church.

Elias Felisian Kifunda (62): Interviewed in panels on October 3, 1992 and February 9, 1993. He is a Fipa, born at Pimbi village on the Fipa plateau. He is a retired catechist and a son and grandson of an iron smelter (in the highlands). He lived in Kala for some time and moved to Kirando in the early 1970s following good farm land. He is a good friend and co-hunter of Fabian Makanta Kimbelekete. He is very conversant with the smelting technique of the Malungu type of technology. He was recruited as a field helper.

Monika Nkana (60): Interviewed in a panel on October 24, 1992. She is a Fipa, born at Kirando. She is a potter, a skill learned from a friend. She taught the skills to her sister's daughter, Maria Nkana (also interviewed).

Kilala Kasombo (58): Interviewed alone on October 10, 1992. She is a Fipa, born at Kirando. Her occupation include farming and potting, learned from her mother.

Timotei Kipara (57): Interviewed alone on February 18, 1993. He is a Fipa, born at Kirando. He is a farmer and iron-smith. The latter skill was learned through apprenticeship from his friend. Timotei himself has two students, both are his grandsons aged 10 and 12.

Mama Ana (57): Interviewed alone on February 20, 1993. She is a Ha, born in Kigoma. She currently lives in Kirando as a registered local healer (mganga wa kienyeji)[2]. Most of the medicines were learned from her mother. She was very resourceful in providing information pertaining to the relationship between iron metallurgy and traditional healing.

Mama Sungura (55): Interviewed in a panel on February 9, 1993. She is a Fipa, born near Chipota on the Fipa escarpment, a daughter of an iron smelter. As a young girl, Sungura often participated in the ritual process of sanctifying the furnace in which a young and "pure" (virgin) girl and a young and "pure" boy put sacrificial materials inside a furnace before smelting process began. Currently, Mama

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[2] Local healers were generally very reluctant to be interviewed. They suspected us to be undercover government agents who frequently visit them to check if they comply with the regulation of their profession. For example some of them claimed, without "scientific proof", that they can cure AIDS patients (charging high fees for nothing). It was easy, however, to interview Mzee Fabian Makanta on local medicine because he was conversant with what we were doing. It was not easy to do that to a mganga who did not know us well. To circumvent this problem I presented myself to Mama Ana as a patient and not as a researcher.

Sungura is heading the District Cultural office at Namanyere.

Albertina Kalimilulu (48): Interviewed alone on October 10, 1992. She is a Fipa, born at Kipili, along the lake shore. She is a farmer and a part-time potter, a skill she learned from a friend. Albertina has lived in several villages south of Kirando and, with this experience she helped us to identify sources of pots and potsherds coming from the shore after examining their form, paste, and decoration.

Maria Kapandila (37): Interviewed in a panel on October 24, 1992. She is a Fipa, born at Ulwile island, off the Kirando shore. Although her mother was a potter, Maria could not learn the skill from her mother because she died when Maria was only two years old. She learned potting from her stepmother, her mother's sister, Monica Nkana (also interviewed).

<u>Kala</u>

Vincent Kayanda (79/80)[3]: Interviewed alone on November 28, 1992. He is a Fipa, born at Kakwemba east of King'ombe (Fipa escarpment) and earning his livelihood through farming and fishing. In his last years he became blind (due to old age). His knowledge about the history of Kala was excellent.

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[3] Sadly, when we revisited his home in October ,1993 (during the last field season) we were told that Mzee Vincent Kayanda had passed away three months before our arrival.

Adriano Buza (71): Interviewed alone on November 28, 1992. He was born at Kipanga near Kasanga, close to the southern tip of Lake Tanganyika. His mother was a Lungu and his father a Muganda who was a cook with some missionaries who had run from Uganda in the late 1890s following the religious skirmishes: Muslims vs Christians and the White Fathers (French) vs the Anglicans (British). Similar to his father, Adriano has remained closely linked with missionaries throughout his lifetime.

Petro Salamba (70): Interviewed alone on November 28, 1992. He is a Fipa, born on the Fipa highlands and moved to Kala when he was a teenager. He is a farmer and a fishermen.

Antoni Kusa (60): Interviewed in a panel on November 28, 1992. He is a Mambwe, born and grew up at Kala, but his parents came from Mambweland, northern Zambia, running from ethnic wars by the beginning of this century. He is a farmer and fisherman.

Joseph Tunduleni (55): Interviewed in a panel on November 28, 1992. He is a Lungu, born and grew up at Kala. His parents, however, came from Ulungu, northern Zambia, following good fishing grounds. He is a farmer and fisherman.

Pius Kandege (54): Interviewed in a panel on November 28, 1992. He is Lungu, born at Kasanga, and came to Kala with his parents about forty years ago. He is a fisherman and farmer. His father and grandfather were iron smelters,

practicing the malungu type of technology. Pius is well informed about iron technology.

Bruno Sakarani (52): Interviewed in a panel on November 28, 1992. He is Lungu, born at and grew up at Kala. He is a carpenter, expert in building fishing canoes.

King'ombe

Julio Kanoni (80): Interviewed alone on February 26, 1993. He is Fipa, born at Matalani, near Kate, on the Fipa plateau. He came to King'ombe when he was a teenager following good farmland. He is very resourceful both in terms of iron-working and socioeconomic history of the area. He is blind.

Kalundi

Paulo Minango (79): Interviewed in a panel on February 24, 1993. He is Fipa, born at Kalundi. Formerly (1930s), he participated in iron smelting as a helper at Kalundi, site Hxlo-5.

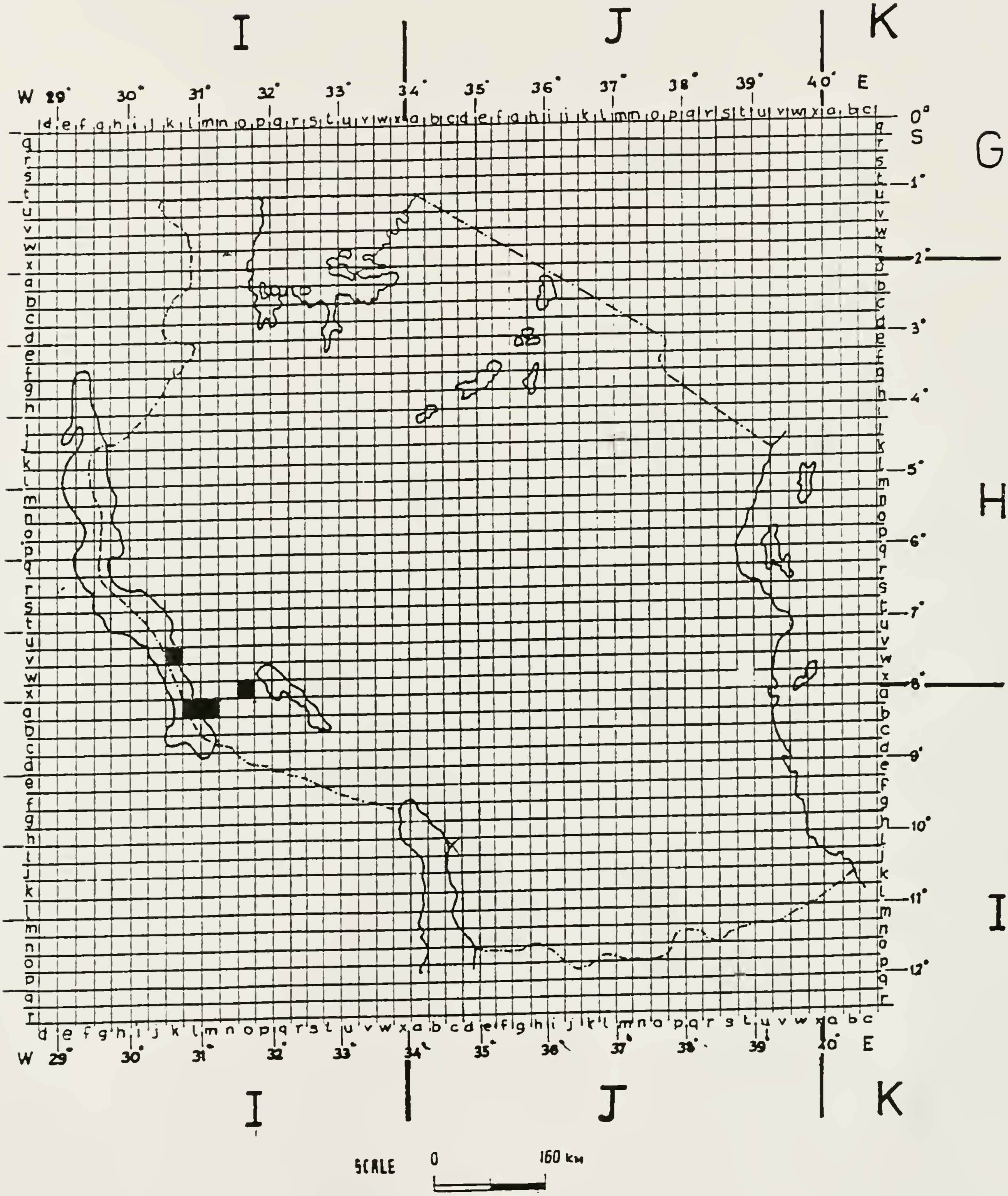
Xavery Mwanakatwe (76): Interviewed in a panel on February 24, 1993. He is Fipa, born at Kipande, but grew up at Kalundi. Between 1934-5 he became a full time helper to a senior smelter (isilungu) at Kalundi, site Hxlo-2. The furnace at which he participated in smelting iron is still standing (Plate 4-1). In this research he was a field helper.

Orabi Noel Chambo (43): Interviewed in a panel on February 24, 1993. He is Fipa, born at Kalundi. Currently he is the

Chairman of Kalundi Village. In this research he was our field helper.

APPENDIX B

S.A.S.E.S. GRID MAP OF TANZANIA SHOWING LOCATIONS OF THE RESEARCH LOCALITIES



APPENDIX C

METALLOGRAPHIC AND EDS ANALYSES OF MATERIALS FROM SOUTHWESTERN TANZANIA

(a) Katukutu Technology

s #	Lab #*	Provenance	Type	Phases
1	084-1	Hvlk-01, U1	B-n	fayalite, glass, wustite, & anorthite.
2	095-1	Hvlk-01, U2B2,	C-n	fayalite, glass, & wustite.
3	190-1	Hvlk-17, U1	bloom	iron, wustite, glass, hercynite & fayalite.
4	193-1	Hvlk-17, U2	B-m	wustite, fayalite, & iron.
5	070-1	Hvlk-17, surface	vitrified wall	fayalite, glass, leucite, wustite, & anorthite.
6	144-1	Hvlk-25, U1B1 B:20-40 cm	bloom	iron, wustite, & leucite.
7	144-2	Hvlk-25, U1B1 B:20-40 cm	PRO	corrosion, wustite, anorthite, quartz, glass & iron.
8	154-1a	Hvlk-25, U1B1, D: 60-70 cm	bloom	iron & corrosion.
9	154-1b	Hvlk-25, U1B1, D: 60-70 cm	bloom	iron & corrosion.
10	157-1	Hvlk-25, U1B2, D: 50-60 cm	B-m	wustite, fayalite, & iron.
11	157-2	Hvlk-25, U1B2, D: 50-60 cm	bloom	iron, wustite, leucite, glass, hercynite & fayalite.
12	158-1	Hvlk-25, U1B2, E:60-70 cm	PRO	corrosion, iron, rock, & quartz.
13	158-2	Hvlk-25, U1B2, E:60-70 cm	B-m	wustite, fayalite, glass, & corrosion.
14	158-3	Hvlk-25, U1B2, E:60-70 cm	B-m	corrosion, wustite, glass, fayalite, & quartz.

* The samples are based on bag numbers. For example, 084-1a stands for bag # 84, 1st sample from this bag and first piece (a) from this sample. The bag catalogue (not provided here) contains information about provenance and the date each sample was collected. Underlining denotes samples analyzed for chemical elements.

s #	Lab #	Provenance	Type	Phases
15	159-1	Hvlk-25, U1B2, F:70-80 cm	B-m	corrosion, wustite, iron, glass, anorthite, fayalite, & hercynite.
16	159-2	Hvlk-25, U1B2, F:70-80 cm	B-n	magnetite, fayalite, glass, wustite, iron, & corrosion.
17	160-1	Hvlk-25, U2B1, A:00-20 cm	B-m	wustite, iron, fayalite & glass
18	160-2	Hvlk-25, U2B1, A:00-20 cm	B-n	wustite, glass & fayalite.
19	160-3	Hvlk-25, U2B1, A:00-20 cm	C-n	Fayalite, wustite, leucite & glass.
20	163-1	Hvlk-25, U2B1, B:20-40 cm	ore	rock.
21	255-1	Ialm-1, U3B2, B:20-30 cm	B-n	fayalite, glass, hercynite & anorthite.
22	259-1	Ialm-1, U5B2, B:45-55 cm	B-n	fayalite, glass & hercynite.
23	259-2	Ialm-1, U5B2, B:45-55 cm	PRO	wustite, rock, quartz, & fayalite.

EDS Reading
070-1 Si, Al, O, Ca, K, Fe, Ti & Mn.
154-1b Si, Ca, Al, Ti, Mg, O, K, Zr, Fe & Mn
157-2 Fe, Si, Al, Ca, O, K, P, Mn, Ti & Cl.
160-3 Si, Fe, Ca, O, Al, P, K & Ti.
163-1 Fe, O, Al & Si.
255-1 Si, Fe, Al, O, Ca, K & Ti

(b) Malungu Technology

s #	Lab #	Provenance	Type	Phases
1	238-1	Hvlk-39, U1B2	B-m	fayalite, glass, wustite, & corrosion
2	238-2	Hvlk-39, U1B2	B-n	wustite, glass, fayalite, hercynite.
3	238-3	Hvlk-39, U1B2,	B-m	fayalite, glass, & wustite.
4	240-1	Hvlk-39, U1B2	C-n	glass, fayalite, & hercynite.
5	204-1	Ialm-1, U1B2 A:00-30 cm	A-n refining	fayalite, glass, hercynite, & iron.
6	266-1	Ialm-4, U1B2 A:00-18 cm	PRO	wustite, hercynite, fayalite
7	217-1	Hxlo-2, U1B2, A: 00-10 cm	A-m	fayalite, magnetite & glass.
8	217-2	Hxlo-2, U1B2, A: 00-10 cm.	C-m	fayalite, glass & iron.
9	217-3	Hxlo-2, U1B2, A: 00-10 cm	bloom	iron, fayalite, glass & corrosion.
10	218-1	Hxlo-2, U1B2, B:10-20 cm	B-n	wustite, fayalite, glass, & magnetite.
11	218-2	Hxlo-2, U1B2, B:10-20 cm	B-m	fayalite, gal, iron, & quartz.
12	219-1	Hxlo-2, U1B2, B:10-20 cm	PRO	quartz, iron, roc, fayalite, hercynite & glass.
13	219-2	Hxlo-2, U1B2, B:10-20 cm	B-m	fayalite, glass, hercynite, iron, & quartz.
14	220-1	Hxlo-2, U1B2, C:20-40 cm	B-m	iron, glass, & corrosion.
15	220-2	Hxlo-2, U1B2, C:20-40 cm	B-n	fayalite, glass, hercynite & anorthite.
16	220-3	Hxlo-2, U1B2, C:20-40 cm	PRO	rock, quartz & fayalite.
17	220-4	Hxlo-2, U1B2, C:20-40 cm	C-m	glass, wustite, fayalite, anorthite & quartz.
18	222-1	Hxlo-3 surface	A-n refining	fayalite, glass & wustite.
19	222-2	Hxlo-3 surface	A-m refining	fayalite, glass, hercynite & iron.
20	223-1	Hxlo-4 surface	ore	rock.

EDS Reading

240-1 Si, Fe, Al, O, Ca, K &Mn.
266-1 Fe, Si, Al & O
220-2 Si, Fe, O, Al, Ca & K.
222-2 Si, Fe, O, Al, Ca &K.
223-1 (bright region) Fe, O, Si & Al
(dark region) Si &O

(c) "Barongo" Technology

s #	Lab #	Provenance	Type	Phases
1	132-1	Hvlk-35, U2B1 A:00-10 cm	B1	hercynite, fayalite, glass, & iron.
2	132-2	Hvlk-35, U2B1 A:00-10 cm	B1	hercynite, fayalite, glass, corrosion, wustite & iron.
3	132-3	Hvlk-35, U2B1 A:00-10 cm	B2	hercynite, fayalite, glass
4	132-4	Hvlk-35, U2B1 A:00-10 cm	B2	wustite, hercynite, fayalite
5	132-5	Hvlk-35, U2B1 A:00-10 cm	B2	magnetite, fayalite, glass
6	044-1	Hvlk-36 surface A:00-10 cm	B2	wustite, fayalite, glass
7	142-1	Hvlk-60, surface	B1	magnetite, fayalite, wustite, glass & iron
8	142-2	Hvlk-60, surface	B1	wustite, glas, magnetite, corrosion, iron, & quartz.

EDS Reading
123-2 Fe, Si, Al, O, Ti, Ca, K, &Cl.
044-1 Fe, Si, O, Ca, Al, Ti, K, Mg &Zr.

(d) Metal Objects

s #	Lab #	Provenance	Type	Microconstituents
1	129-1	Hvlk-35, U1B1 A:00-10 cm	iron hoe	iron + (wustite & glass).
2	284-1	Hvlk-58, U3B1 C:20-30cm	iron nail	iron + (glass).
3	309-1	Kalundi ethno.	iron hoe	iron + (wustite, fayalite & glass).

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I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

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